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PCT

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## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(54) Title: INHIBITORS OF p38			
(57) Abstract			
<p>The present invention relates to inhibitors of p38, a mammalian protein kinase involved in cell proliferation, cell death and response to extracellular stimuli. The invention also relates to methods for producing these inhibitors. The invention also provides pharmaceutical compositions comprising the inhibitors of the invention and methods of utilizing these compositions in the treatment and prevention of various disorders.</p>			

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WO 99/00357

PCT/US98/13496

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INHIBITORS OF p38TECHNICAL FIELD OF INVENTION

10           The present invention relates to inhibitors  
of p38, a mammalian protein kinase involved cell  
proliferation, cell death and response to extracellular  
stimuli. The invention also relates to methods for  
producing these inhibitors. The invention also  
15       provides pharmaceutical compositions comprising the  
inhibitors of the invention and methods of utilizing  
those compositions in the treatment and prevention of  
various disorders.

20

BACKGROUND OF THE INVENTION

Protein kinases are involved in various  
cellular responses to extracellular signals. Recently,  
a family of mitogen-activated protein kinases (MAPK)  
25       have been discovered. Members of this family are  
Ser/Thr kinases that activate their substrates by  
phosphorylation [B. Stein et al., Ann. Rep. Med. Chem.,  
31, pp. 289-98 (1996)]. MAPKs are themselves activated  
by a variety of signals including growth factors,  
30       cytokines, UV radiation, and stress-inducing agents.

One particularly interesting MAPK is p38.  
p38, also known as cytokine suppressive anti-  
inflammatory drug binding protein (CSBP) and RK, was  
isolated from murine pre-B cells that were transfected  
35       with the lipopolysaccharide (LPS) receptor CD14 and  
induced with LPS. p38 has since been isolated and

WO 99/00357

PCT/US98/13496

-2-

sequenced, as has the cDNA encoding it in humans and mouse. Activation of p38 has been observed in cells stimulated by stresses, such as treatment of lipopolysaccharides (LPS), UV, anisomycin, or osmotic shock, and by cytokines, such as IL-1 and TNF.

Inhibition of p38 kinase leads to a blockade on the production of both IL-1 and TNF. IL-1 and TNF stimulate the production of other proinflammatory cytokines such as IL-6 and IL-8 and have been implicated in acute and chronic inflammatory diseases and in post-menopausal osteoporosis [R. B. Kimble et al., Endocrinol., 136, pp. 3054-61 (1995)].

Based upon this finding it is believed that p38, along with other MAPKs, have a role in mediating cellular response to inflammatory stimuli, such as leukocyte accumulation, macrophage/monocyte activation, tissue resorption, fever, acute phase responses and neutrophilia. In addition, MAPKs, such as p38, have been implicated in cancer, thrombin-induced platelet aggregation, immunodeficiency disorders, autoimmune diseases, cell death, allergies, osteoporosis and neurodegenerative disorders. Inhibitors of p38 have also been implicated in the area of pain management through inhibition of prostaglandin endoperoxide synthase-2 induction. Other diseases associated with IL-1, IL-6, IL-8 or TNF overproduction are set forth in WO 96/21654.

Others have already begun trying to develop drugs that specifically inhibit MAPKs. For example, PCT publication WO 95/31451 describes pyrazole compounds that inhibit MAPKs, and in particular p38. However, the efficacy of these inhibitors in vivo is still being investigated.

Accordingly, there is still a great need to develop other potent, p38-specific inhibitors that are

WO 99/00357

PCT/US98/13496

-3-

useful in treating various conditions associated with p38 activation.

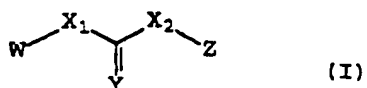
#### SUMMARY OF THE INVENTION

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The present invention solves this problem by providing compounds which demonstrate strong and specific inhibition of p38.

These compounds have the general formula:

10



15

wherein:

W is a saturated, partially saturated or aromatic monocyclic or bicyclic ring system containing 0-4  
20 heteroatoms selected from N, O, and S, wherein W optionally comprises up to 4 substituents independently selected from R<sup>1</sup> and R<sup>4</sup>;

wherein R<sup>1</sup> is halogen, OR<sup>3</sup>, NO<sub>2</sub>, NH<sub>2</sub>, N(R<sup>3</sup>)<sub>2</sub>, CO<sub>2</sub>R<sup>3</sup>, CON(R<sup>3</sup>)<sub>2</sub>, COR<sup>3</sup>, NHCOR<sup>3</sup>, SO<sub>2</sub>NR<sup>3</sup>, CN, SR<sup>3</sup>, 1,2-  
25 methyleneoxy, 1,2-ethylenedioxy or CF<sub>3</sub>;

Y is O, S or NH;

X<sub>1</sub> and X<sub>2</sub> are independently selected from O, S or NR<sup>2</sup>;

wherein R<sup>2</sup> is selected from H or C<sub>1</sub>-C<sub>6</sub>  
30 straight or branched alkyl, C<sub>2</sub>-C<sub>6</sub> straight or branched alkenyl or alkynyl, wherein R<sup>2</sup> is optionally substituted with -OH,

WO 99/00357

PCT/US98/13496

-4-

$-N(R^3)_2$ ,  $-Z$ ,  $-CO_2R^3$  or  $-CO-N(R^3)_2$ ;

$R^3$  is selected from H,  $C_1-C_6$  straight or branched alkyl,  $C_2-C_6$  straight or branched alkenyl or alkynyl, or  $C_6-20$  aryl wherein  $R^3$  optionally contains up to 4 substituents selected from halo,  $-OH$ ,  $-OR^4$ ,  $-NO_2$ ,  $-NH_2$ ,  $-N(R^4)_2$ ,  $-CO_2R^4$ ,  $-CO-N(R^4)_2$ ,  $-Z$ ,  $-CN$ ,  $-SR^4$ ,  $CF_3$  or  $-SO_2NR^4$ ;

$R^4$  is independently H,  $(C_1-C_6)$ -straight or branched alkyl,  $(C_2-C_6)$ -straight or branched alkenyl or alkynyl;

$Z$  is selected from  $C_3-C_7$ -cycloalkyl,  $C_5-C_7$ -cycloalkenyl or aromatic or non-aromatic 5-7 membered monocyclic or bicyclic ring containing 0-4 heteroatoms selected from N, O and S, wherein  $Z$  optionally comprises up to 4 substituents independently selected from  $R^1$  and  $R^4$ .

In another embodiment, the invention provides pharmaceutical compositions comprising the p38 inhibitors of this invention. These compositions may be utilized in methods for treating or preventing a variety of disorders, such as cancer, inflammatory diseases, autoimmune diseases, destructive bone disorders, proliferative disorders, infectious diseases, viral diseases and neurodegenerative diseases. These compositions are also useful in methods for preventing cell death and hyperplasia and therefore may be used to treat or prevent reperfusion/ischemia in stroke, heart attacks, organ hypoxia. The compositions are also useful in methods for preventing thrombin-induced platelet aggregation. Each of these above-described methods is also part of the present invention.

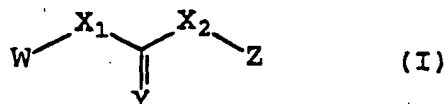
WO 99/00357

PCT/US98/13496

-5-

DETAILED DESCRIPTION OF THE INVENTION

The present invention provides inhibitors of p38 having the general formula:



10 wherein W is a saturated, partially saturated or an aromatic monocyclic or bicyclic ring system containing 0-4 heteroatoms independently selected from N, O, and S, wherein W optionally comprises up to 4 substituents independently selected from R<sup>1</sup> and R<sup>4</sup>.

15 R<sup>1</sup> is selected from halogen, OR<sup>3</sup>, NO<sub>2</sub>, NH<sub>2</sub>, N(R<sup>3</sup>)<sub>2</sub>, CO<sub>2</sub>R<sup>3</sup>, CON(R<sup>3</sup>)<sub>2</sub>, COR<sup>3</sup>, NHCOR<sup>3</sup>, SO<sub>2</sub>NR<sup>3</sup>, CN, SR<sup>3</sup>, 1,2-methyleneoxy, 1,2-ethylenedioxy or CF<sub>3</sub>.

Y is O, S or NH.

20 X<sub>1</sub> and X<sub>2</sub> are independently selected from O, S or NR<sup>2</sup>.

wherein R<sup>2</sup> is selected from H or C<sub>1</sub>-C<sub>6</sub> straight or branched alkyl, C<sub>2</sub>-C<sub>6</sub> straight or branched alkenyl or alkynyl, wherein R<sup>2</sup> is optionally substituted with -OH, -N(R<sup>3</sup>)<sub>2</sub>, -Z, -CO<sub>2</sub>R<sup>3</sup> or -CO-N(R<sup>3</sup>)<sub>2</sub>.

25 R<sup>3</sup> is selected from H, C<sub>1</sub>-C<sub>6</sub> straight or branched alkyl, C<sub>2</sub>-C<sub>6</sub> straight or branched alkenyl or alkynyl or C<sub>6</sub>-20 aryl, wherein R<sup>3</sup> optionally contains up to 4 substituents selected from halo, -OH, -OR<sup>4</sup>, -NO<sub>2</sub>, -NH<sub>2</sub>, -N(R<sup>4</sup>)<sub>2</sub>, -CO<sub>2</sub>R<sup>4</sup>, -CO-N(R<sup>4</sup>)<sub>2</sub>, -Z, -CN, -SR<sup>4</sup>, CF<sub>3</sub> or

30



-6-

-SO<sub>2</sub>NR<sup>4</sup>.

R<sup>4</sup> is independently H, (C<sub>1</sub>-C<sub>6</sub>)-straight or branched alkyl, (C<sub>2</sub>-C<sub>6</sub>)-straight or branched alkenyl or alkynyl.

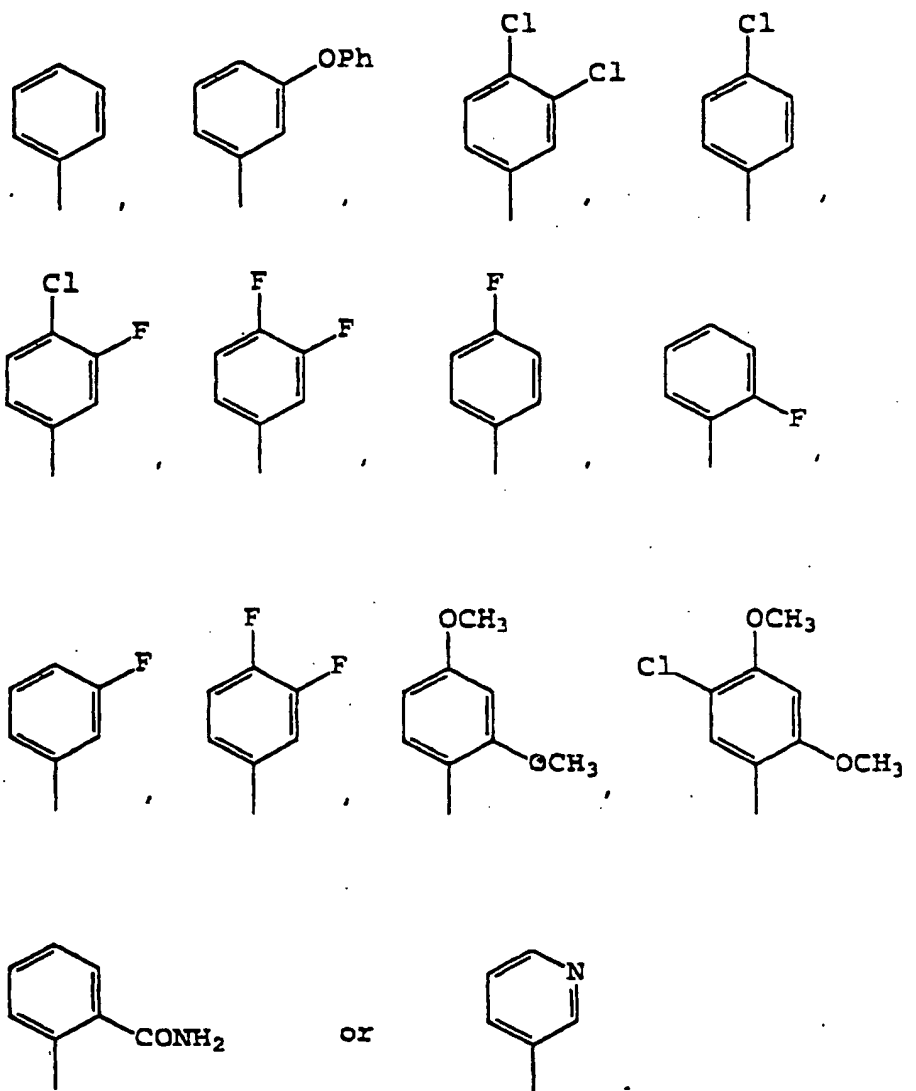
5           Z is selected from C<sub>3</sub>-C<sub>7</sub>-cycloalkyl, C<sub>5</sub>-C<sub>7</sub>-cycloalkenyl or aromatic or non-aromatic 5-7 membered monocyclic or bicyclic ring systems containing 0-4 heteroatoms selected from N, O and S, wherein Z optionally comprises up to 4 substituents independently  
10           selected from R<sup>1</sup> and R<sup>4</sup>.

          According to a preferred embodiment, W is an aromatic or non-aromatic 5-7 membered monocyclic ring containing up to 3 heteroatoms selected from O, S and N, and optionally containing up to 3 substituents  
15           selected from halo, OR<sup>3</sup>, NO<sub>2</sub>, NH<sub>2</sub>, N(R<sup>3</sup>)<sub>2</sub>, CO<sub>2</sub>R<sup>3</sup>, CON(R<sup>3</sup>)<sub>2</sub>, COR<sup>3</sup>, NHCOR<sup>3</sup>, SO<sub>2</sub>NR<sup>3</sup>, CN, SR<sup>3</sup>, 1,2-methyleneoxy, 1,2-ethylenedioxy, CF<sub>3</sub>, (C<sub>1</sub>-C<sub>6</sub>)-straight or branched alkyl, (C<sub>2</sub>-C<sub>6</sub>)-straight or branched alkenyl or alkynyl.

20           According to a more preferred embodiment, W phenyl or pyridyl, each containing up to 3 substituents selected from halo, OR<sup>3</sup>, NO<sub>2</sub>, NH<sub>2</sub>, N(R<sup>3</sup>)<sub>2</sub>, CO<sub>2</sub>R<sup>3</sup>, CON(R<sup>3</sup>)<sub>2</sub>, COR<sup>3</sup>, NHCOR<sup>3</sup>, SO<sub>2</sub>NR<sup>3</sup>, CN, SR<sup>3</sup>, 1,2-methyleneoxy, 1,2-ethylenedioxy, CF<sub>3</sub> or (C<sub>1</sub>-C<sub>6</sub>)-straight  
25           or branched alkyl.

-7-

Some specific examples of the preferred W are:



5

Most preferably, W is phenyl, 3,4-dichlorophenyl, 2-fluorophenyl or 2-amidophenyl.

According to a preferred embodiment, Z is a

5-7 membered aromatic or non aromatic ring system,

optionally containing up to 4 heteroatoms independently  
selected from N, O and S, wherein Z optionally

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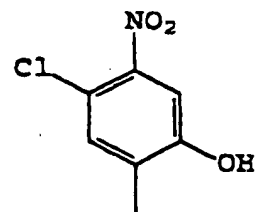
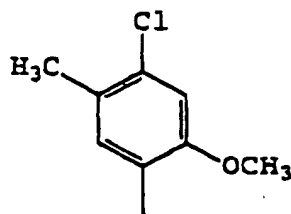
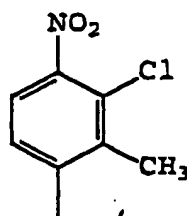
-8-

comprises up to 4 substituents selected from halo,  $OR^3$ ,  $NO_2$ ,  $NH_2$ ,  $N(R^3)_2$ ,  $CO_2R^3$ ,  $CON(R^3)_2$ ,  $COR^3$ ,  $NHCOR^3$ ,  $SO_2NR^3$ ,  $CN$ ,  $SR^3$ , 1,2-methyleneoxy, 1,2-ethylenedioxy,  $CF_3$ ,  $(C_1-C_6)$ -straight or branched alkyl,  $(C_2-C_6)$ -straight or branched alkenyl or alkynyl.

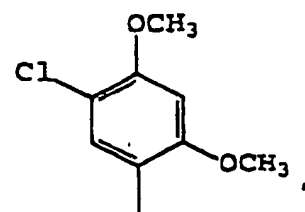
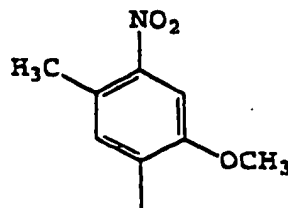
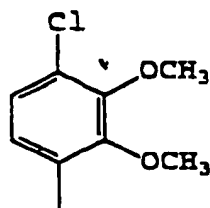
According to a more preferred embodiment, Z is selected from phenyl or pyridyl, each containing up to 3 substituents selected from halo,  $OR^3$ ,  $NO_2$ ,  $NH_2$ ,  $N(R^3)_2$ ,  $CO_2R^3$ ,  $CON(R^3)_2$ ,  $COR^3$ ,  $NHCOR^3$ ,  $SO_2NR^3$ ,  $CN$ ,  $SR^3$ , 1,2-methyleneoxy, 1,2-ethylenedioxy,  $CF_3$  or  $(C_1-C_6)$ -straight or branched alkyl.

According to an even more preferred embodiment, Z is a 2,4,5-trisubstituted phenyl or a 3,4-disubstituted phenyl, wherein the substituents are selected from halo,  $OR^3$ ,  $NO_2$ ,  $NH_2$ ,  $N(R^3)_2$ ,  $CO_2R^3$ ,  $CON(R^3)_2$ ,  $COR^3$ ,  $NHCOR^3$ ,  $SO_2NR^3$ ,  $CN$ ,  $SR^3$ , 1,2-methyleneoxy, 1,2-ethylenedioxy,  $CF_3$  or  $(C_1-C_6)$ -straight or branched alkyl.

Some specific examples of preferred Z are:



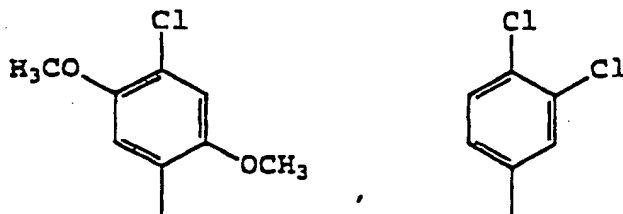
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WO 99/00357

PCT/US98/13496

-9-



Most preferred are compounds wherein 2 is 4-chloro-2-methyl-5-nitro-phenyl, 4-chloro-2-methoxy-5-methyl-phenyl, 5-chloro-2-hydroxy-4-nitrophenyl, 2,4-dimethoxy-5-chlorophenyl, 2-methoxy-4-nitro-5-methylphenyl, 2,5-dimethoxy-4-chlorophenyl, 3,4-dichlorophenyl.

According to another preferred embodiment, Y is O or S. Most preferably, Y is O.

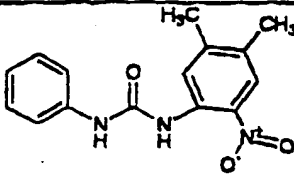
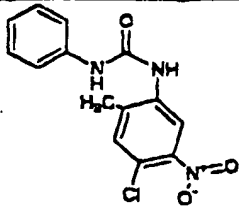
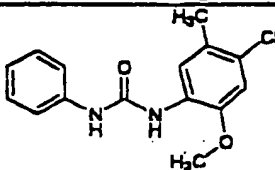
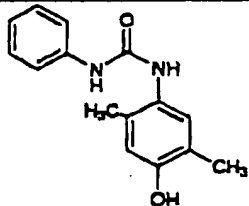
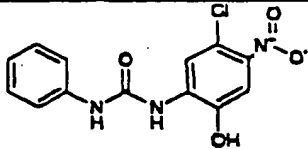
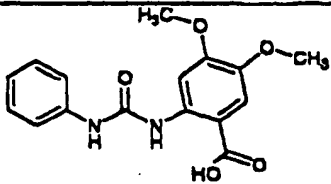
According to another preferred embodiment,  $X_1$  and  $X_2$  are independently O or  $NR^2$ . More preferably,  $X_1$  and  $X_2$  are both  $NR^2$ . Most preferably,  $X_1$  and  $X_2$  are both NH.

Some specific inhibitors of this invention are set forth in Table 1 below.

TABLE 1

compound number	Structure
1	

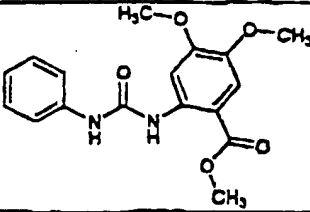
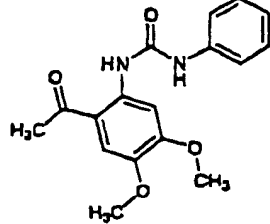
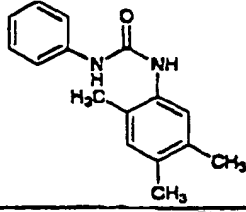
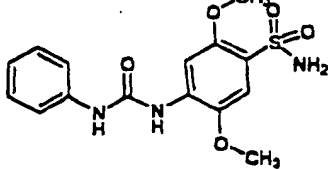
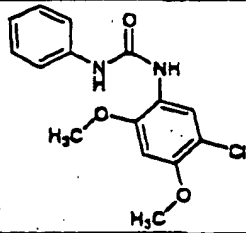
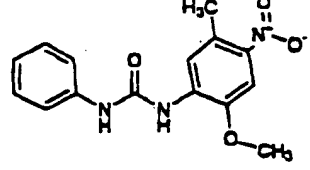
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compound number	Structure
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WO 99/00357

PCT/US98/13496

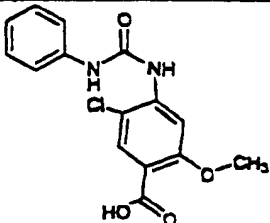
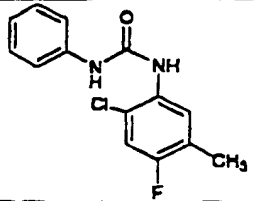
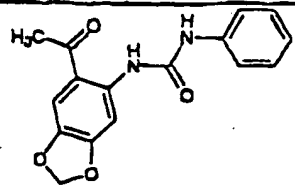
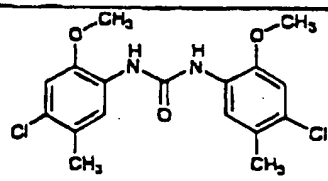
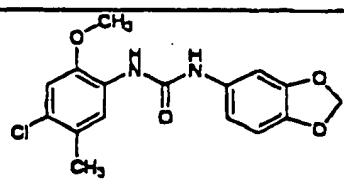
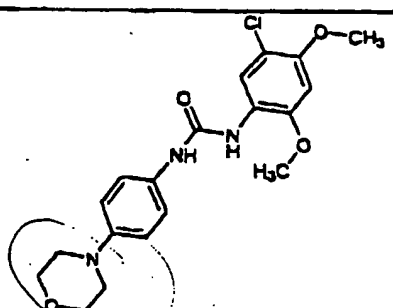
-11-

compound number	Structure
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WO 99/00357

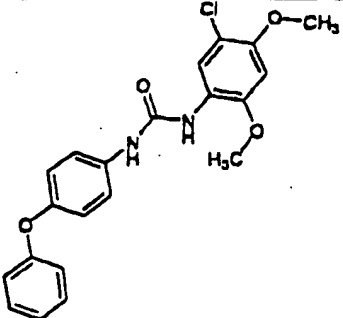
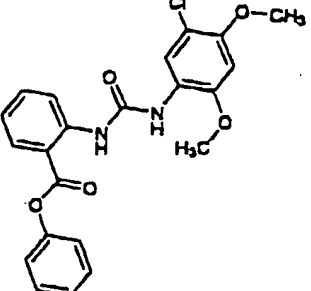
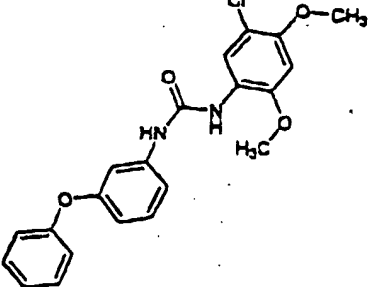
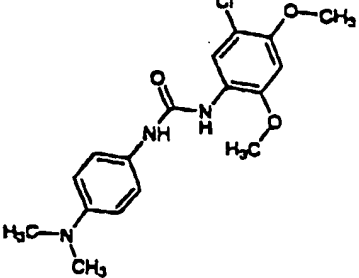
PCT/US98/13496

-12-

compound number	Structure
14	
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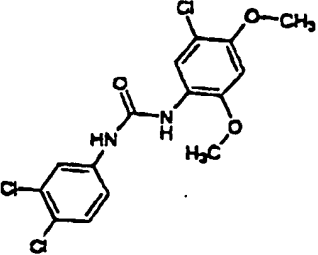
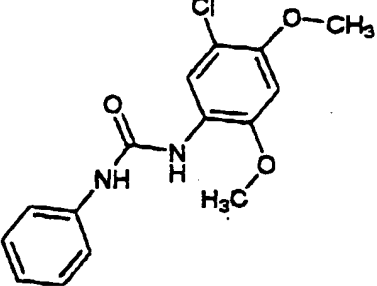
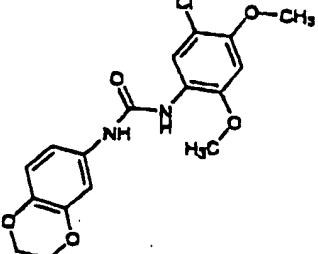
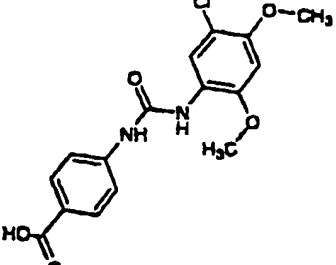
↑  
"biogenic system"

-13-

compound number	Structure
20	 <chem>COc1cc(Cl)cc(NC(=O)c2ccc(Oc3ccccc3)cc2)c1</chem>
21	 <chem>COc1cc(Cl)cc(NC(=O)c2ccccc2C(=O)Oc3ccccc3)c1</chem>
22	 <chem>COc1cc(Cl)cc(NC(=O)c2ccc(Oc3ccccc3)cc2)c1</chem>
23	 <chem>COc1cc(Cl)cc(NC(=O)c2ccc(N(C)C)cc2)c1</chem>



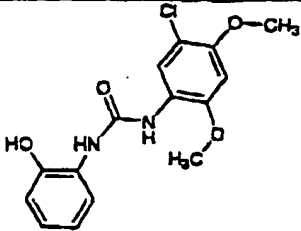
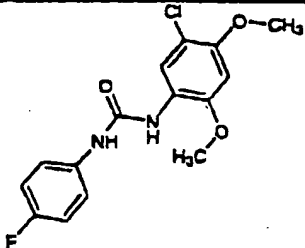
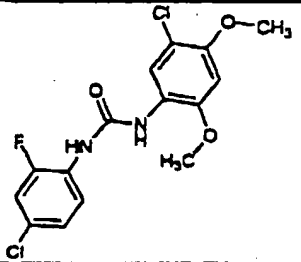
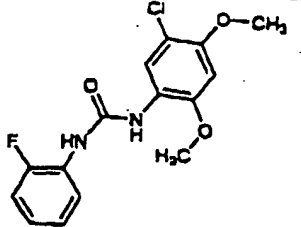
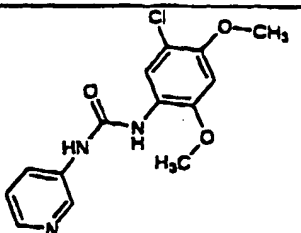
-14-

compound number	Structure
24	 <chem>COc1cc(Cl)c(NC(=O)Nc2cc(Cl)cc(Cl)c2)oc1CC</chem>
25	 <chem>COc1cc(Cl)c(NC(=O)Nc2ccccc2)oc1C</chem>
26	 <chem>COc1cc(Cl)c(NC(=O)Nc2ccc3c(c2)OCO3)oc1C</chem>
27	 <chem>COc1cc(Cl)c(NC(=O)Nc2ccc(C(=O)O)cc2)oc1C</chem>

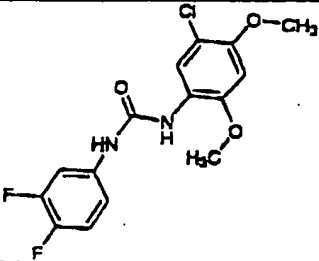
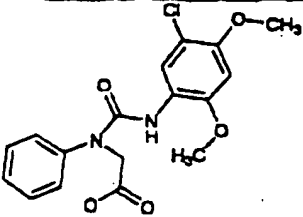
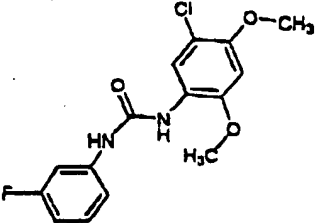
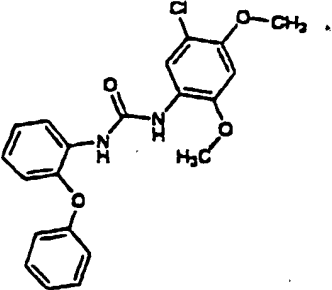
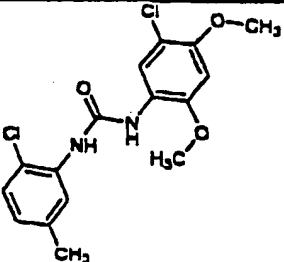
WO 99/00357

PCT/US98/13496

-15-

compound number	Structure
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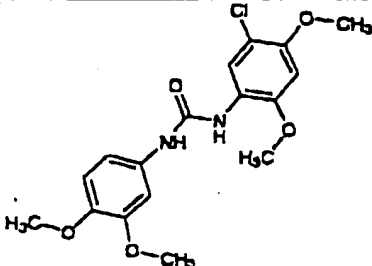
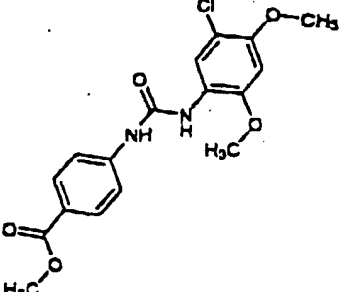
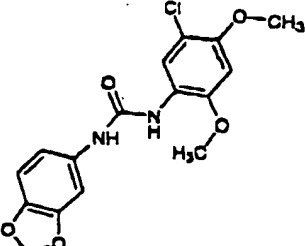
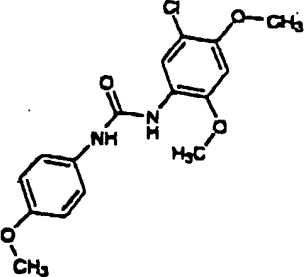
-16-

compound number	Structure
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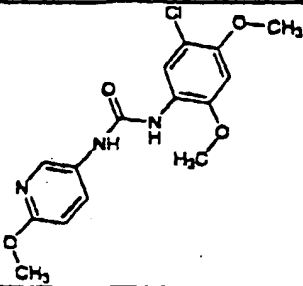
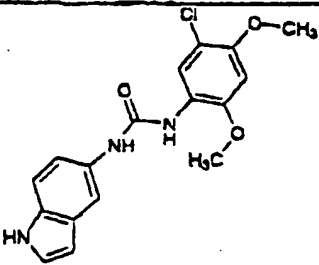
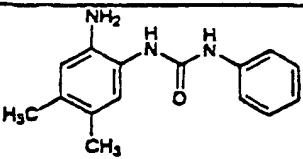
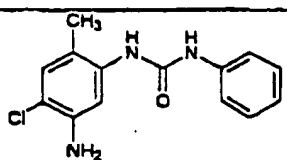
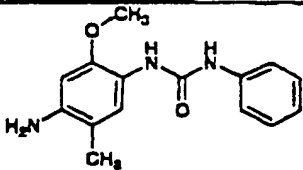
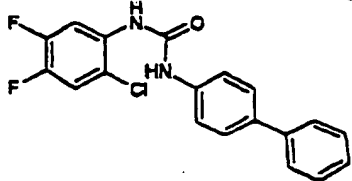
-17-

compound number	Structure
38	 <chem>COc1cc(OC)cc(NC(=O)c2ccc(OC)c(OC)c2)c1Cl</chem>
39	 <chem>COc1cc(OC)cc(NC(=O)c2ccc(cc2)C(=O)OC)c1Cl</chem>
40	 <chem>COc1cc(OC)cc(NC(=O)c2c3ccccc3oc2)c1Cl</chem>
41	 <chem>COc1cc(OC)cc(NC(=O)c2ccc(OC)cc2)c1Cl</chem>

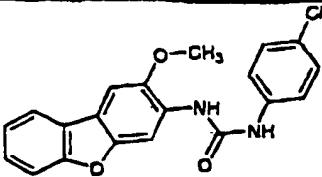
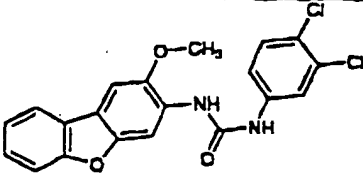
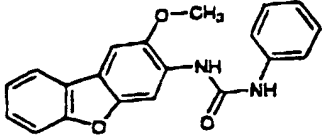
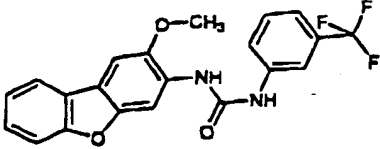
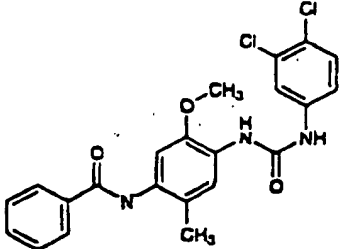
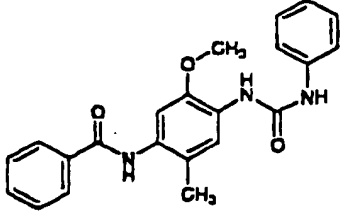
WO 99/00357

PCT/US98/13496

-18-

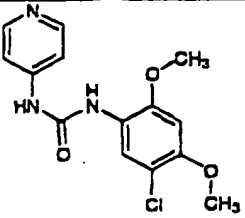
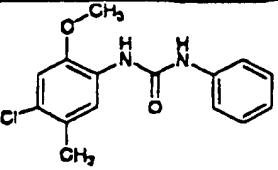
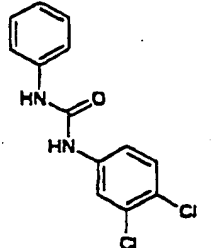
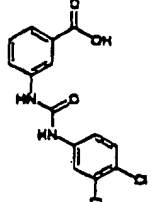
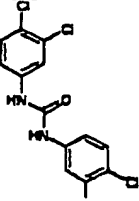
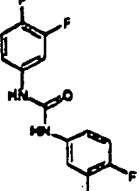
compound number	Structure
42	
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-19-

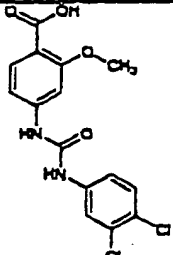
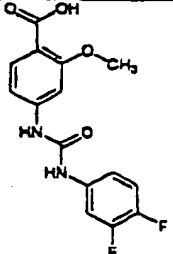
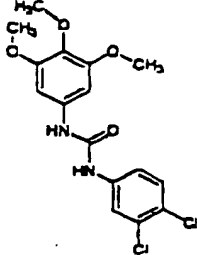
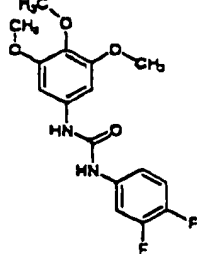
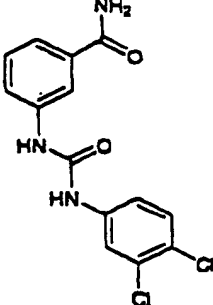
compound number	Structure
48	
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compound number	Structure
54	 <chem>CC1=CC=C(C=C1NC(=O)c2ccccc2)C(=O)Nc3cc(OC)c(C)cc3NC(=O)Nc4ccc(Cl)cc4</chem>
55	 <chem>CC1=CC=C(C=C1NC(=O)c2ccccc2)C(=O)Nc3cc(OC)c(C)cc3NC(=O)Nc4ccc(C(F)(F)F)cc4</chem>
56	 <chem>CC(=O)c1cc2c(c1)OCO2C(=O)Nc3ccc(Cl)cc3</chem>
57	 <chem>CC(=O)c1cc2c(c1)OCO2C(=O)Nc3ccc(Cl)cc3</chem>
58	 <chem>COc1cc2c(c1)OCO2C(=O)Nc3ccc(Cl)cc3</chem>
59	 <chem>COc1cc2c(c1)OCO2C(=O)Nc3ccc(Cl)cc3</chem>

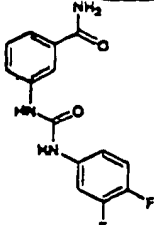
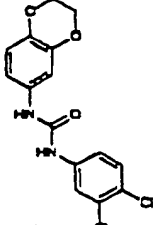
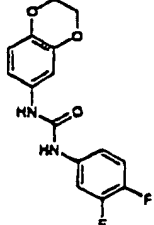
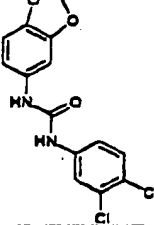
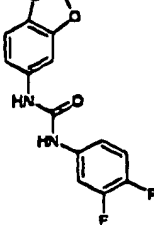
-21-

compound number	Structure
60	 <chem>COc1cc(Cl)cc(OC)c1NC(=O)Nc2ccncc2</chem>
61	 <chem>CC1=CC=C(C=C1NC(=O)Nc2cc(Cl)cc(C)c2)C</chem>
62	 <chem>Clc1cc(Cl)ccc1NC(=O)Nc2ccccc2</chem>
63	 <chem>OC(=O)c1ccccc1NC(=O)Nc2cc(Cl)cc(Cl)c2</chem>
64	 <chem>Clc1cc(Cl)ccc1NC(=O)Nc2cc(Cl)cc(Cl)c2</chem>
65	 <chem>Fc1cc(F)ccc1NC(=O)Nc2cc(F)cc(F)c2</chem>



compound number	Structure
66	 <chem>COc1cc(ccc1C(=O)O)NC(=O)Nc2cc(Cl)cc(Cl)c2</chem>
67	 <chem>COc1cc(ccc1C(=O)O)NC(=O)Nc2cc(F)cc(F)c2</chem>
68	 <chem>COc1cc(OC)cc(NC(=O)Nc2cc(Cl)cc(Cl)c2)c1</chem>
69	 <chem>COc1cc(OC)cc(NC(=O)Nc2cc(F)cc(F)c2)c1</chem>
70	 <chem>Nc1ccccc1NC(=O)Nc2cc(Cl)cc(Cl)c2</chem>

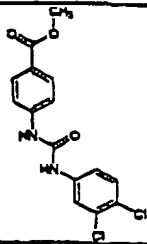
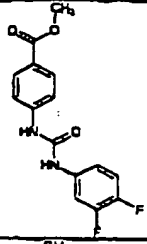
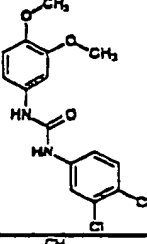
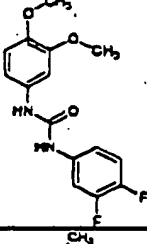
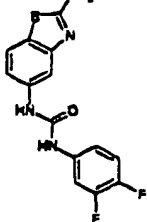
-23-

compound number	Structure
71	 <chem>Nc1cc(=O)nc(NC(=O)c2cc(F)c(F)cc2)c1</chem>
72	 <chem>Clc1cc(Cl)nc(NC(=O)c2cc(F)c(F)cc2)c1</chem>
73	 <chem>Fc1cc(F)nc(NC(=O)c2cc(F)c(F)cc2)c1</chem>
74	 <chem>Clc1cc(Cl)c2c(c1)oc3cc(NC(=O)c4cc(F)c(F)cc4)ccc32</chem>
75	 <chem>Fc1cc(F)c2c(c1)oc3cc(NC(=O)c4cc(F)c(F)cc4)ccc32</chem>

WO 99/00357

PCT/US98/13496

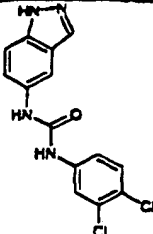
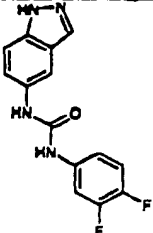
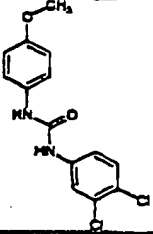
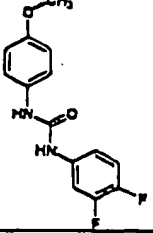
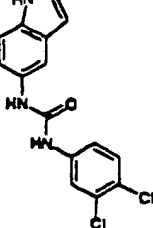
-24-

compound number	Structure
76	
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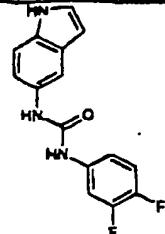
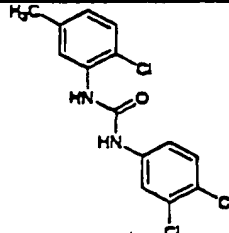
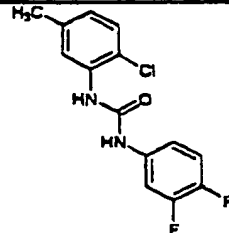
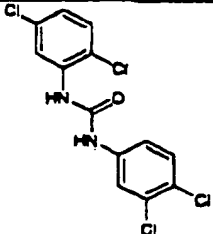
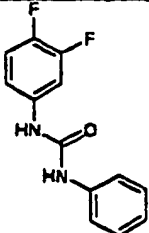
WO 99/00357

PCT/US98/13496

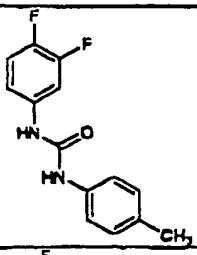
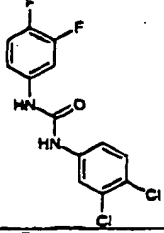
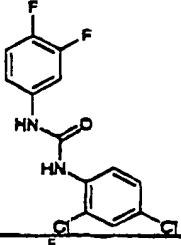
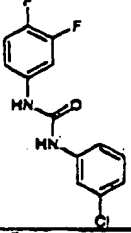
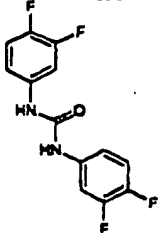
-25-

compound number	Structure
81	
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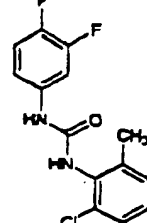
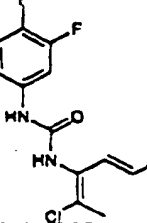
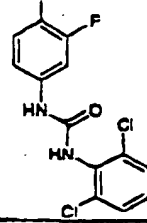
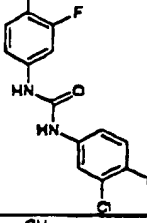
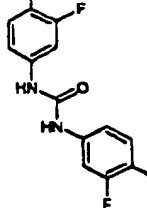
-26-

compound number	Structure
86	 <chem>O=C1C=CC=C(C1c2ccccc2N)Nc3cc(F)c(F)cc3</chem>
87	 <chem>Cc1cc(Cl)ccc1Nc2cc(Cl)ccc2NC(=O)c3ccccc3N4C=CC=C4c5ccccc54</chem>
88	 <chem>Cc1cc(Cl)ccc1Nc2cc(Cl)ccc2NC(=O)c3ccccc3N4C=CC=C4c5ccccc54</chem>
89	 <chem>Clc1cc(Cl)ccc1Nc2cc(Cl)ccc2NC(=O)c3ccccc3N4C=CC=C4c5ccccc54</chem>
90	 <chem>O=C1C=CC=C(C1c2ccccc2N)Nc3cc(F)c(F)cc3</chem>

-27-

compound number	Structure
91	 <chem>Cc1ccc(NC(=O)Nc2cc(F)c(F)cc2)cc1</chem>
92	 <chem>Clc1cc(NC(=O)Nc2cc(F)c(F)cc2)cc(Cl)c1</chem>
93	 <chem>Clc1cc(NC(=O)Nc2cc(F)c(F)cc2)cc(OC3=CC=C(Cl)C=C3)c1</chem>
94	 <chem>Clc1ccc(NC(=O)Nc2cc(F)c(F)cc2)cc1</chem>
95	 <chem>Fc1cc(NC(=O)Nc2cc(F)c(F)cc2)cc(F)c1</chem>

-28-

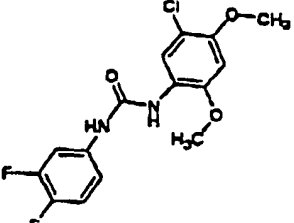
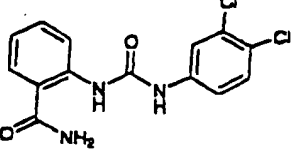
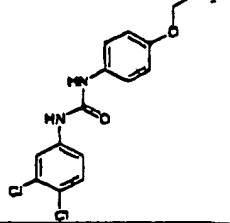
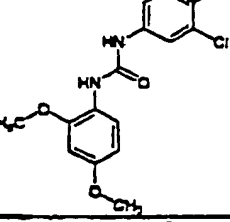
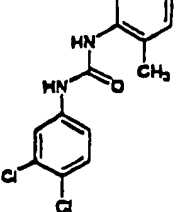
compound number	Structure
96	 <chem>Cc1cc(Cl)c2c(c1)nc(=O)nc2Nc3ccc(F)c(F)c3</chem>
97	 <chem>C=C(Cl)C(C)Nc1cc(Cl)c2c(c1)nc(=O)nc2Nc3ccc(F)c(F)c3</chem>
98	 <chem>Clc1cc(Cl)c2c(c1)nc(=O)nc2Nc3ccc(F)c(F)c3</chem>
99	 <chem>Cc1cc(Cl)c2c(c1)nc(=O)nc2Nc3ccc(F)c(F)c3</chem>
100	 <chem>Cc1cc(F)c2c(c1)nc(=O)nc2Nc3ccc(F)c(F)c3</chem>

-29-

compound number	Structure
101	 <chem>COc1ccncc1NC(=O)Nc2ccc(Cl)cc2</chem>
102	 <chem>COc1ccncc1NC(=O)Nc2cc(F)c(F)cc2</chem>
103	 <chem>COc1ccncc1NC(=O)Nc2cc(C)c(Cl)cc2</chem>
104	 <chem>COc1ccncc1NC(=O)Nc2cc(F)c(F)cc2</chem>
105	 <chem>COc1cc2c(c1)OCO2NC(=O)Nc3cc(Cl)c(Cl)cc3</chem>



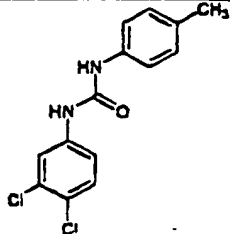
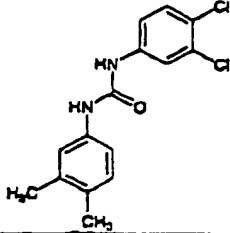
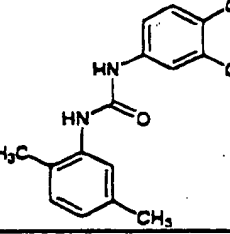
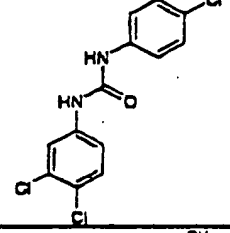
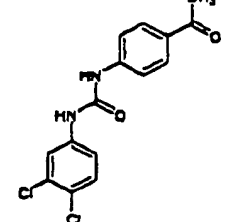
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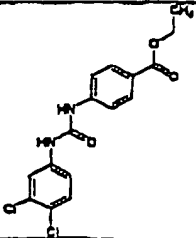
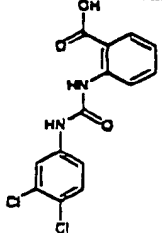
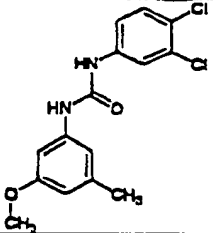
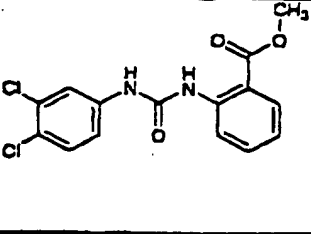
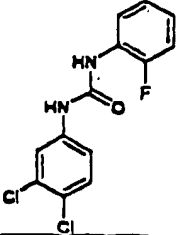
compound number	Structure
106	 <chem>COc1cc(Cl)c2c(c1)nc(NC(=O)Nc3cc(F)c(F)cc3)oc2C</chem>
107	 <chem>Cc1cc(Cl)c2c(c1)nc(NC(=O)Nc3cc(N)ccc3)oc2</chem>
108	 <chem>COc1ccc(NC(=O)Nc2cc(Cl)c3c2oc(C)c3)cc1</chem>
109	 <chem>COc1cc(NC(=O)Nc2cc(Cl)c3c2oc(C)c3)cc(OC)c1</chem>
110	 <chem>Cc1cc(Cl)c2c(c1)nc(NC(=O)Nc3cc(Cl)c(Cl)cc3)oc2</chem>

WO 99/00357

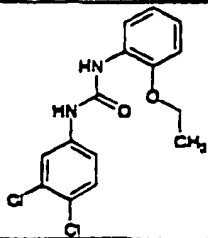
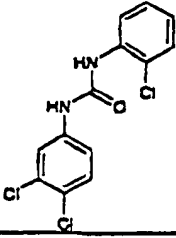
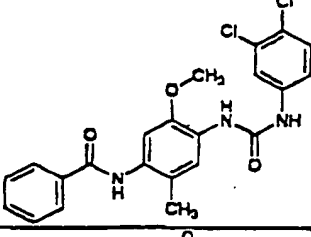
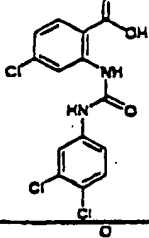
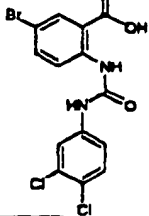
PCT/US98/13496

-31-

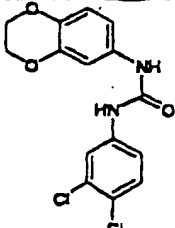
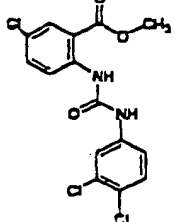
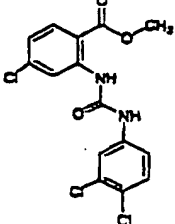
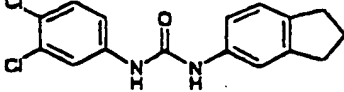
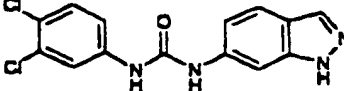
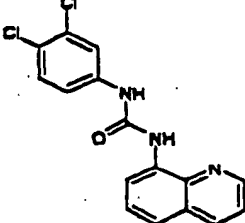
compound number	Structure
111	
112	
113	
114	
115	

compound number	Structure
116	 <chem>CCOC(=O)c1ccc(cc1)NC(=O)c2ccc(cc2)NC(=O)c3cc(Cl)cc(Cl)c3</chem>
117	 <chem>O=C1C=CC(=C(C=C1)NC(=O)c2ccc(cc2)NC(=O)c3cc(Cl)cc(Cl)c3)C(=O)O</chem>
118	 <chem>COc1cc(C)cc(cc1NC(=O)c2ccc(cc2)NC(=O)c3cc(Cl)cc(Cl)c3)OC</chem>
119	 <chem>COC(=O)c1ccccc1NC(=O)Nc2ccc(cc2)NC(=O)c3cc(Cl)cc(Cl)c3</chem>
120	 <chem>Fc1ccccc1NC(=O)Nc2ccc(cc2)NC(=O)c3cc(Cl)cc(Cl)c3</chem>

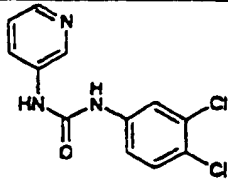
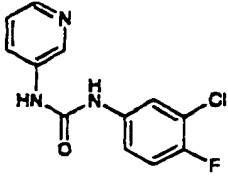
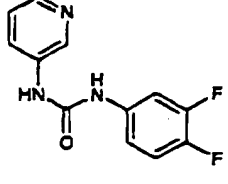
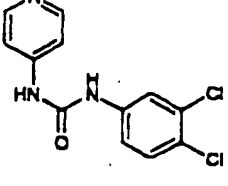
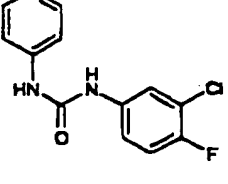
-33-

compound number	Structure
121	
122	
123	
124	
125	

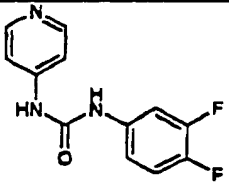
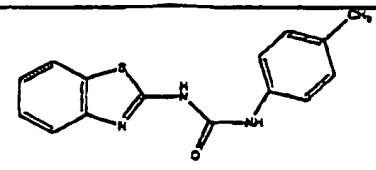
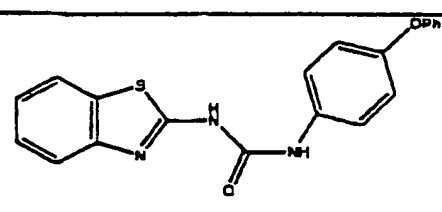
-34-

compound number	Structure
126	 <chem>O=C1C=CC(OC1c2ccccc2)NC(=O)c3cc(Cl)cc(Cl)c3</chem>
127	 <chem>COC(=O)c1cc2c(c1)OC2C(=O)Nc3cc(Cl)cc(Cl)c3</chem>
128	 <chem>COC(=O)c1cc2c(c1)OC2C(=O)Nc3cc(Cl)cc(Cl)c3</chem>
129	 <chem>O=C1C=CC(OC1c2ccccc2)NC(=O)c3cc(Cl)cc(Cl)c3</chem>
130	 <chem>O=C1C=CC(OC1c2ccccc2)NC(=O)c3cc(Cl)cc(Cl)c3</chem>
131	 <chem>O=C1C=CC(OC1c2ccccc2)NC(=O)c3cc(Cl)cc(Cl)c3</chem>

-35-

compound number	Structure
132	 <chem>Nc1ccncc1C(=O)Nc2cc(Cl)cc(Cl)c2</chem>
133	 <chem>Nc1ccncc1C(=O)Nc2cc(F)c(Cl)cc2</chem>
134	 <chem>Nc1ccncc1C(=O)Nc2cc(F)c(F)cc2</chem>
135	 <chem>Nc1ccncc1C(=O)Nc2cc(Cl)cc(Cl)c2</chem>
136	 <chem>Nc1ccncc1C(=O)Nc2cc(F)c(Cl)cc2</chem>

-36-

compound number	Structure
137	
138	
139	

Preferred compounds of the present invention are compound numbers 3, 4, 6, 12, 13, 22, 24, 25, 29-31, 33, 35, 61, 64, 105-107, 114 and 120.

More preferred compounds of the present invention are compound numbers 3, 4, 6, 12, 13, 24, 31, 61, 64, 105 and 107.

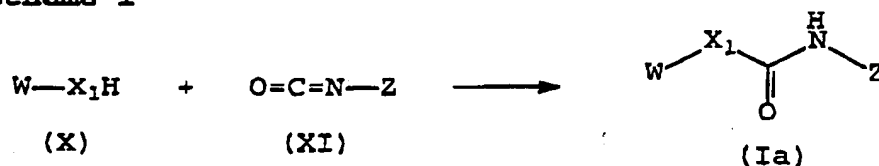
Compounds of formula (I) may be obtained using conventional synthetic techniques. Preferably, these compounds are chemically synthesized from readily available starting materials. Modular and convergent methods are also preferred. In a convergent approach, for example, large sections of the final product are brought together in the final stages of the synthesis.

-37-

rather than by incremental addition of small pieces to a growing molecular fragment.

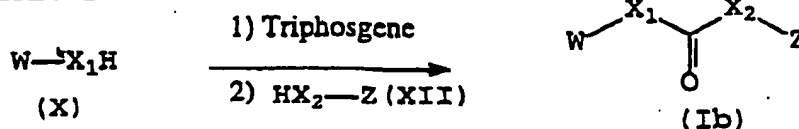
Scheme I illustrates a representative example of a convergent process for the synthesis of compounds of formula (Ia), a subset of compounds of formula (I), wherein Y is oxygen and X<sub>2</sub> is NH. The process comprises the reaction of an isocyanate of formula (XI) with an amine, thiol or a hydroxyl compound of formula (X) in a solvent such as methylene chloride. Compounds of formula (I), wherein Y is S or NH can be readily obtained through the process of Scheme 1 by using the thioisocyanate or guanidino analogue of compound of formula (XI), respectively.

Scheme 1



Scheme 2 illustrates a representative example of a convergent process for the synthesis of compounds of formula (Ib), a subset of compounds of formula (I), wherein Y is oxygen. A compound of formula (X) is reacted with a coupling reagent such as phosgene, or a phosgene equivalent such as triphosgene, or diethyl carbonate, followed by reaction with a compound of formula (XII) to yield compound of formula (Ib).

Scheme 2





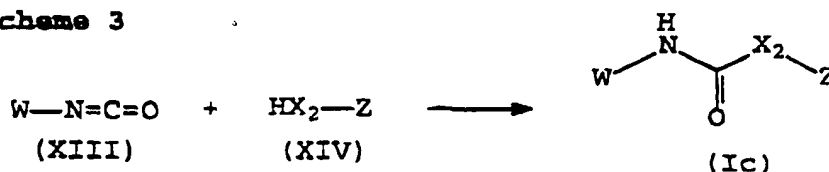
WO 99/00357

PCT/US98/13496

-38-

Scheme 3 illustrates a representative example of a convergent process for the synthesis of compounds of formula (Ic), a subset of compounds of formula (I), wherein Y is oxygen and X<sub>1</sub> is NH.

Scheme 3



The process of Scheme 3 comprises the reaction of an isocyanate of formula (XIII) with an amine, thiol or a hydroxyl compound of formula (XIV), in a solvent such as methylene chloride, to yield compounds of formula (Ic). Compounds of formula (I), wherein Y is S or NH can be readily obtained through the process of Scheme 3 by using the thioisocyanate or guanidino analogue of compound of formula (XIII), respectively.

The activity of the p38 inhibitors of this invention may be assayed *in vitro*, *in vivo* or in a cell line. *In vitro* assays include assays that determine inhibition of either the kinase activity or ATPase activity of activated p38. Alternate *in vitro* assays quantitate the ability of the inhibitor to bind to p38 and may be measured either by radiolabelling the inhibitor prior to binding, isolating the inhibitor/p38 complex and determining the amount of radiolabel bound, or by running a competition experiment where new inhibitors are incubated with p38 bound to known radioligands. These and other useful *in vitro* and cell

-39-

culture assays are well known to those of skill in the art.

Cell culture assays of the inhibitory effect of the compounds of this invention may be used to  
5 determine the amounts of TNF, IL-1, IL-6 or IL-8 produced in whole blood or cell fractions thereof in cells treated with inhibitor as compared to cells treated with negative controls. Level of these cytokines may be determined through the use of  
10 commercially available ELISAs.

An *in vivo* assay useful for determining the inhibitory activity of the p38 inhibitors of this invention are the suppression of hindpaw edema in rats with *Mycobacterium butyricum*-induced adjuvant  
15 arthritis. This is described in J.C. Boehm et al., J. Med. Chem., 39, pp. 3929-37 (1996), the disclosure of which is herein incorporated by reference. The p38 inhibitors of this invention may also be assayed in animal models of arthritis, bone resorption, endotoxin  
20 shock and immune function, as described in A. M. Badger et al., J. Pharmacol. Experimental Therapeutics, 279, pp. 1453-61 (1996), the disclosure of which is herein incorporated by reference.

The p38 inhibitors or pharmaceutical salts thereof may be formulated into pharmaceutical  
25 compositions for administration to animals or humans. These pharmaceutical compositions, which comprise an amount of p38 inhibitor effective to treat or prevent a p38-mediated condition and a pharmaceutically  
30 acceptable carrier, are another embodiment of the present invention. The term "p38-mediated condition" as used herein means any disease or other deleterious condition in which p38 is known to play a role. This includes conditions which are known to be caused by IL-  
35 1, TNF, IL-6 or IL-8 overproduction. Such conditions include, without limitation, inflammatory diseases,

-40-

autoimmune diseases, destructive bone disorders, proliferative disorders, infectious diseases, viral disease, and neurodegenerative diseases.

5 Inflammatory diseases which may be treated or prevented include, but are not limited to, acute pancreatitis, chronic pancreatitis, asthma, allergies, and adult respiratory distress syndrome.

10 Autoimmune diseases which may be treated or prevented include, but are not limited to, glomerulonephritis, rheumatoid arthritis, systemic lupus erythematosus, scleroderma, chronic thyroiditis, Graves' disease, autoimmune gastritis, insulin-dependent diabetes mellitus (Type I), autoimmune hemolytic anemia, autoimmune neutropenia, 15 thrombocytopenia, atopic dermatitis, chronic active hepatitis, myasthenia gravis, multiple sclerosis, inflammatory bowel disease, ulcerative colitis, Crohn's disease, psoriasis, or graft vs. host disease.

20 Destructive bone disorders which may be treated or prevented include, but are not limited to, osteoporosis, osteoarthritis and multiple myeloma-related bone disorder.

25 Proliferative diseases which may be treated or prevented include, but are not limited to, acute myelogenous leukemia, chronic myelogenous leukemia, metastatic melanoma, Kaposi's sarcoma, and multiple myeloma.

30 Infectious diseases which may be treated or prevented include, but are not limited to, sepsis, septic shock, and Shigellosis.

Viral diseases which may be treated or prevented include, but are not limited to, acute hepatitis infection (including hepatitis A, hepatitis B and hepatitis C), HIV infection and CMV retinitis.

-41-

Degenerative conditions or diseases which may be treated or prevented by the compounds of this invention include, but are not limited to, Alzheimer's disease, Parkinson's disease, cerebral ischemia and other neurodegenerative diseases.

"p38-mediated conditions" also include ischemia/reperfusion in stroke, heart attacks, myocardial ischemia, organ hypoxia, vascular hyperplasia, cardiac hypertrophy and thrombin-induced platelet aggregation.

In addition, p38 inhibitors of this invention are also capable of inhibiting the expression of inducible pro-inflammatory proteins such as prostaglandin endoperoxide synthase-2 (PGHS-2), also referred to as cyclooxygenase-2 (COX-2). Therefore, other "p38-mediated conditions" are edema, analgesia, fever and pain, such as neuromuscular pain, headache, cancer pain, dental pain and arthritis pain.

The conditions and diseases that may be treated or prevented by the p38 inhibitors of this invention may also be conveniently grouped by the cytokine (e.g., IL-1, TNF, IL-6, IL-8) that is believed to be responsible for the disease.

Thus, an IL-1-mediated disease or condition includes rheumatoid arthritis, osteoarthritis, stroke, endotoxemia and/or toxic shock syndrome, inflammatory reaction induced by endotoxin, inflammatory bowel disease, tuberculosis, atherosclerosis, muscle degeneration, cachexia, psoriatic arthritis, Reiter's syndrome, gout, traumatic arthritis, rubella arthritis, acute synovitis, diabetes, pancreatic  $\beta$ -cell disease and Alzheimer's disease.

A TNF-mediated disease or condition includes rheumatoid arthritis, rheumatoid spondylitis, osteoarthritis, gouty arthritis and other arthritic conditions, sepsis, septic shock, endotoxic shock, gram

WO 99/00357

PCT/US98/13496

-42-

negative sepsis, toxic shock syndrome, adult  
respiratory distress syndrome, cerebral malaria,  
chronic pulmonary inflammatory disease, silicosis,  
pulmonary sarcoidosis, bone resorption diseases,  
5 reperfusion injury, graft vs. host reaction, allograft  
rejections, fever and myalgias due to infection,  
cachexia secondary to infection, AIDS, ARC or  
malignancy, keloid formation, scar tissue formation,  
Crohn's disease, ulcerative colitis or pyresis. TNF-  
10 mediated diseases also include viral infections, such  
as HIV, CMV, influenza and herpes; and veterinary viral  
infections, such as lentivirus infections, including,  
but not limited to equine infectious anaemia virus,  
caprine arthritis virus, visna virus or maedi virus; or  
15 retrovirus infections, including feline  
immunodeficiency virus, bovine immunodeficiency virus,  
or canine immunodeficiency virus.

IL-8 mediated disease or condition includes  
diseases characterized by massive neutrophil  
20 infiltration, such as psoriasis, inflammatory bowel  
disease, asthma, cardiac and renal reperfusion injury,  
adult respiratory distress syndrome, thrombosis and  
glomerulonephritis.

In addition, the compounds of this infection  
25 may be used topically to treat or prevent conditions  
caused or exacerbated by IL-1 or TNF. Such conditions  
include inflamed joints, eczema, psoriasis,  
inflammatory skin conditions such as sunburn,  
inflammatory eye conditions such as conjunctivitis,  
30 pyresis, pain and other conditions associated with  
inflammation.

Pharmaceutically acceptable carriers that may  
be used in these pharmaceutical compositions include,  
but are not limited to, ion exchangers, alumina,  
35 aluminum stearate, lecithin, serum proteins, such as  
human serum albumin, buffer substances such as

WO 99/00357

PCT/US98/13496

-43-

phosphates, glycine, sorbic acid, potassium sorbate, partial glyceride mixtures of saturated vegetable fatty acids, water, salts or electrolytes, such as protamine sulfate, disodium hydrogen phosphate, potassium  
5 hydrogen phosphate, sodium chloride, zinc salts, colloidal silica, magnesium trisilicate, polyvinyl pyrrolidone, cellulose-based substances, polyethylene glycol, sodium carboxymethyl-cellulose, polyacrylates, waxes, polyethylene-polyoxypropylene-block polymers,  
10 polyethylene glycol and wool fat.

The compositions of the present invention may be administered orally, parenterally, by inhalation spray, topically, rectally, nasally, buccally, vaginally or via an implanted reservoir. The term  
15 "parenteral" as used herein includes subcutaneous, intravenous, intramuscular, intra-articular, intra-synovial, intrasternal, intrathecal, intrahepatic, intralesional and intracranial injection or infusion techniques. Preferably, the compositions are  
20 administered orally, intraperitoneally or intravenously.

Sterile injectable forms of the compositions of this invention may be aqueous or oleaginous suspension. These suspensions may be formulated  
25 according to techniques known in the art using suitable dispersing or wetting agents and suspending agents. The sterile injectable preparation may also be a sterile injectable solution or suspension in a non-toxic parenterally-acceptable diluent or solvent, for  
30 example as a solution in 1,3-butanediol. Among the acceptable vehicles and solvents that may be employed are water, Ringer's solution and isotonic sodium chloride solution. In addition, sterile, fixed oils are conventionally employed as a solvent or suspending  
35 medium. For this purpose, any bland fixed oil may be employed including synthetic mono- or di-glycerides.

WO 99/00357

PCT/US98/13496

-44-

Fatty acids, such as oleic acid and its glyceride derivatives are useful in the preparation of injectables, as are natural pharmaceutically-acceptable oils, such as olive oil or castor oil, especially in their polyoxyethylated versions. These oil solutions or suspensions may also contain a long-chain alcohol diluent or dispersant, such as carboxymethyl cellulose or similar dispersing agents which are commonly used in the formulation of pharmaceutically acceptable dosage forms including emulsions and suspensions. Other commonly used surfactants, such as Tweens, Spans and other emulsifying agents or bioavailability enhancers which are commonly used in the manufacture of pharmaceutically acceptable solid, liquid, or other dosage forms may also be used for the purposes of formulation.

The pharmaceutical compositions of this invention may be orally administered in any orally acceptable dosage form including, but not limited to, capsules, tablets, aqueous suspensions or solutions. In the case of tablets for oral use, carriers which are commonly used include lactose and corn starch. Lubricating agents, such as magnesium stearate, are also typically added. For oral administration in a capsule form, useful diluents include lactose and dried corn starch. When aqueous suspensions are required for oral use, the active ingredient is combined with emulsifying and suspending agents. If desired, certain sweetening, flavoring or coloring agents may also be added.

Alternatively, the pharmaceutical compositions of this invention may be administered in the form of suppositories for rectal administration. These can be prepared by mixing the agent with a suitable non-irritating excipient which is solid at room temperature but liquid at rectal temperature and

-45-

therefore will melt in the rectum to release the drug. Such materials include cocoa butter, beeswax and polyethylene glycols.

5 The pharmaceutical compositions of this invention may also be administered topically, especially when the target of treatment includes areas or organs readily accessible by topical application, including conditions and diseases of the eye, the skin, or the lower intestinal tract. Suitable topical  
10 formulations are readily prepared for each of these areas or organs.

Topical application for the lower intestinal tract can be effected in a rectal suppository formulation (see above) or in a suitable enema  
15 formulation. Topically-transdermal patches may also be used.

For topical applications, the pharmaceutical compositions may be formulated in a suitable ointment containing the active component suspended or dissolved  
20 in one or more carriers. Carriers for topical administration of the compounds of this invention include, but are not limited to, mineral oil, liquid petrolatum, white petrolatum, propylene glycol, polyoxyethylene, polyoxypropylene compound, emulsifying  
25 wax and water. Alternatively, the pharmaceutical compositions can be formulated in a suitable lotion or cream containing the active components suspended or dissolved in one or more pharmaceutically acceptable carriers. Suitable carriers include, but are not  
30 limited to, mineral oil, sorbitan monostearate, polysorbate 60, cetyl esters wax, cetearyl alcohol, 2-octyldodecanol, benzyl alcohol and water.

For ophthalmic use, the pharmaceutical compositions may be formulated as micronized  
35 suspensions in isotonic, pH adjusted sterile saline, or, preferably, as solutions in isotonic, pH adjusted



-46-

sterile saline, either with or without a preservative such as benzylalkonium chloride. Alternatively, for ophthalmic uses, the pharmaceutical compositions may be formulated in an ointment such as petrolatum.

5           The pharmaceutical compositions of this invention may also be administered by nasal aerosol or inhalation. Such compositions are prepared according to techniques well-known in the art of pharmaceutical formulation and may be prepared as solutions in saline,  
10       employing benzyl alcohol or other suitable preservatives, absorption promoters to enhance bioavailability, fluorocarbons, and/or other conventional solubilizing or dispersing agents.

          The amount of p38 inhibitor that may be  
15       combined with the carrier materials to produce a single dosage form will vary depending upon the host treated the particular mode of administration. Preferably, the compositions should be formulated so that a dosage of between 0.01 - 100 mg/kg body weight/day of the  
20       inhibitor can be administered to a patient receiving these compositions.

          It should also be understood that a specific dosage and treatment regimen for any particular patient will depend upon a variety of factors, including the  
25       activity of the specific compound employed, the age, body weight, general health, sex, diet, time of administration, rate of excretion, drug combination, and the judgment of the treating physician and the severity of the particular disease being treated. The  
30       amount of inhibitor will also depend upon the particular compound in the composition.

          According to another embodiment, the invention provides methods for treating or preventing a p38-mediated condition comprising the step of  
35       administering to a patient one of the above-described

-47-

pharmaceutical compositions. The term "patient", as used herein, means an animal, preferably a human.

Preferably, that method is used to treat or prevent a condition selected from inflammatory  
5 diseases, autoimmune diseases, destructive bone disorders, proliferative disorders, infectious diseases, degenerative diseases, allergies, reperfusion/ischemia in stroke, heart attacks, organ hypoxia, vascular hyperplasia, cardiac hypertrophy, and  
10 thrombin-induced platelet aggregation.

According to another embodiment, the inhibitors of this invention are used to treat or prevent an IL-1, IL-6, IL-8 or TNF-mediated disease or condition. Such conditions are described above.

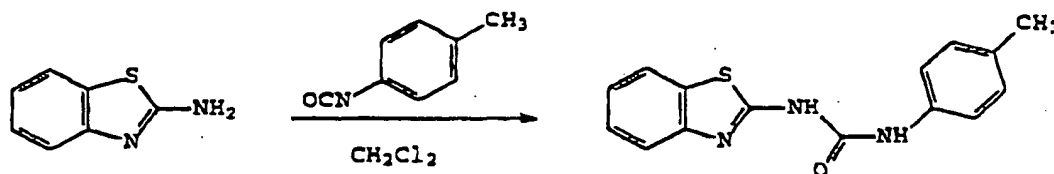
15 Depending upon the particular p38-mediated condition to be treated or prevented, additional drugs, which are normally administered to treat or prevent that condition may be administered together with the inhibitors of this invention. Those additional agents  
20 may be administered separately, as part of a multiple dosage regimen, from the p38 inhibitor-containing composition. Alternatively, those agents may be part of a single dosage form, mixed together with the p38 inhibitor in a single composition.

25 All references cited are herein incorporated by reference.

In order that the invention described herein may be more fully understood, the following examples are set forth. It should be understood that these  
30 examples are for illustrative purposes only and are not to be construed as limiting this invention in any manner.

35

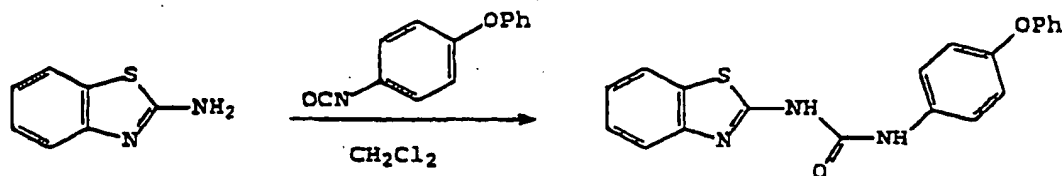
-48-

EXAMPLE 1Synthesis of p38 Inhibitor Compound 138

5

2-amino benzothiazole (500 mg, 2.77 mmol) and 4-methylphenylisocyanate (301  $\mu\text{L}$ , 2.77 mmol) were stirred together at room temperature using methylene chloride as a solvent (50 mL). The product from this reaction precipitated from the solvent mixture and was filtered and washed with methylene chloride to yield pure product: 232 mg, 30 % yield. TLC  $R_f$  = 0.55 eluting with 10% methanol in methylene chloride.

15

EXAMPLE 2Synthesis of p38 Inhibitor Compound 139

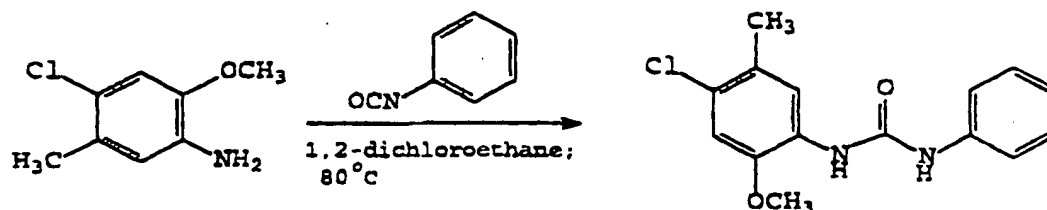
20

The same procedure as Example 1 was followed using 4-phenoxyphenylisocyanate. The same scale was used. Pure product was obtained 0.896 mg, 89% yield,  $R_f$  = 0.31 eluting with 10% methanol in methylene chloride.

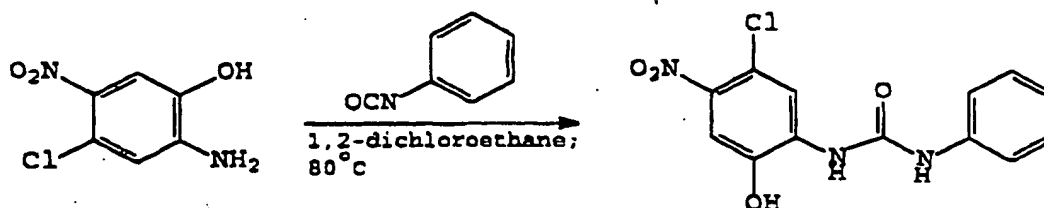
WO 99/00357

PCT/US98/13496

-49-

EXAMPLE 3Synthesis of p38 Inhibitor Compound 4

5                    4-chloro-2-methoxy-5-methylaniline (34.3 mg, 0.2 mmol) and a 1M solution of phenylisocyanate in 1,2 dichloroethane (270 ul, 0.27 mmol) were stirred together at 80°C in 1,2 dichloroethane (1 mL). The reaction was heated overnight, then cooled and passed  
10 through a Varian Bond-Elut SCX cation exchange resin. The filtrate was evaporated in vacuo to yield pure product.

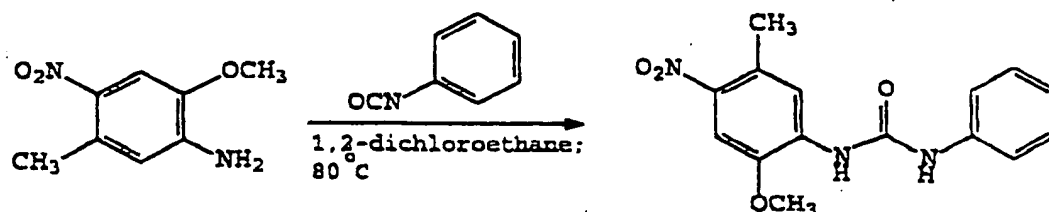
EXAMPLE 4Synthesis of p38 Inhibitor Compound 6

15                    2-amino-4-chloro-5-nitrophenol (41.4 mg, 0.22 mmol) and a 1M solution of phenylisocyanate in 1,2 dichloroethane (270 ul, 0.27 mmol) were stirred together at 80°C in 1,2 dichloroethane (1 mL). The reaction was heated overnight, then cooled and passed  
20 through a Varian Bond-Elut SCX cation exchange resin. The filtrate was evaporated in vacuo to yield pure product.  
25

WO 99/00357

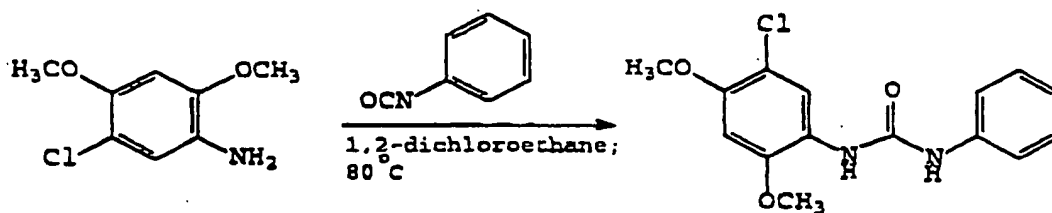
PCT/US98/13496

-50-

EXAMPLE 5Synthesis of p38 Inhibitor Compound 13

5                    3-methyl-4-nitro-o-anisidine (37.8 mg, 0.207  
mmol) and a 1M solution of phenylisocyanate in 1,2  
dichloroethane (270  $\mu$ l, 0.27 mmol) were stirred  
together at 80°C in 1,2 dichloroethane (1 mL). The  
reaction was heated overnight, then cooled and passed  
10 through a Varian Bond-Elut SCX cation exchange resin.  
The filtrate was evaporated in vacuo to yield pure  
product.

15

EXAMPLE 6Synthesis of p38 Inhibitor Compound 13

20                    5-chloro-2,4-dimethoxyaniline (39.1 mg, 0.208  
mmol) and a 1M solution of phenylisocyanate in 1,2  
dichloroethane (270  $\mu$ l, 0.27 mmol) were stirred  
together at 80°C in 1,2 dichloroethane (1 mL). The  
reaction was heated overnight, then cooled. Product  
precipitated from the reaction and was filtered and  
25 washed with dichloroethane to yield pure product.

-51-

EXAMPLE 7Cloning of p38 Kinase in Insect Cells

Two splice variants of human p38 kinase,  
5 CSBP1 and CSBP2, have been identified. Specific  
oligonucleotide primers were used to amplify the coding  
region of CSBP2 cDNA using a HeLa cell library  
(Stratagene) as a template. The polymerase chain  
reaction product was cloned into the pET-15b vector  
10 (Novagen). The baculovirus transfer vector, pVL-  
(His)6-p38 was constructed by subcloning a XbaI-BamHI  
fragment of pET15b-(His)6-p38 into the complementary  
sites in plasmid pVL1392 (Pharmingen).

The plasmid pVL-(His)6-p38 directed the  
15 synthesis of a recombinant protein consisting of a 23-  
residue peptide (MGSSHHHHHSSGLVPRGSHMLE, where LVPRGS  
represents a thrombin cleavage site) fused in frame to  
the N-terminus of p38, as confirmed by DNA sequencing  
and by N-terminal sequencing of the expressed protein.  
20 Monolayer culture of *Spodoptera frugiperda* (Sf9) insect  
cells (ATCC) was maintained in TNM-FH medium (Gibco  
BRL) supplemented with 10% fetal bovine serum in a T-  
flask at 27°C. Sf9 cells in log phase were co-  
transfected with linear viral DNA of Autographa  
25 californica nuclear polyhedrosis virus (Pharmingen) and  
transfer vector pVL-(His)6-p38 using Lipofectin  
(Invitrogen). The individual recombinant baculovirus  
clones were purified by plaque assay using 1% low  
melting agarose.

30

EXAMPLE 8Expression And Purification of Recombinant p38 Kinase

*Trichoplusia ni* (Tn-368) High-Five™ cells  
(Invitrogen) were grown in suspension in Excel-405  
35 protein free medium (JRH Bioscience) in a shaker flask  
at 27°C. Cells at a density of  $1.5 \times 10^6$  cells/ml were

-52-

infected with the recombinant baculovirus described above at a multiplicity of infection of 5. The expression level of recombinant p38 was monitored by immunoblotting using a rabbit anti-p38 antibody (Santa Cruz Biotechnology). The cell mass was harvested 72 hours after infection when the expression level of p38 reached its maximum.

Frozen cell paste from cells expressing the (His)<sub>6</sub>-tagged p38 was thawed in 5 volumes of Buffer A (50 mM NaH<sub>2</sub>PO<sub>4</sub> pH 8.0, 200 mM NaCl, 2mM  $\beta$ -Mercaptoethanol, 10% Glycerol and 0.2 mM PMSF). After mechanical disruption of the cells in a Microfluidizer, the lysate was centrifuged at 30,000 x g for 30 minutes. The supernatant was incubated batchwise for 3-5 hours at 4°C with Talon™ (Clontech) metal affinity resin at a ratio of 1 ml of resin per 2-4 mgs of expected p38. The resin was settled by centrifugation at 500 x g for 5 minutes and gently washed batchwise with Buffer A. The resin was slurried and poured into a column (approx. 2.6 x 5.0 cm) and washed with Buffer A + 5 mM imidazole.

The (His)<sub>6</sub>-p38 was eluted with Buffer A + 100 mM imidazole and subsequently dialyzed overnight at 4°C against 2 liters of Buffer B, (50 mM HEPES, pH 7.5, 25 mM  $\beta$ -glycerophosphate, 5% glycerol, 2mM DTT). The His<sub>6</sub> tag was removed by addition of at 1.5 units thrombin (Calbiochem) per mg of p38 and incubation at 20°C for 2-3 hours. The thrombin was quenched by addition of 0.2 mM PMSF and then the entire sample was loaded onto a 2 ml benzamidine agarose (American International Chemical) column.

The flow through fraction was directly loaded onto a 2.6 x 5.0 cm Q-Sepharose (Pharmacia) column previously equilibrated in Buffer B + 0.2 mM PMSF. The p38 was eluted with a 20 column volume linear gradient to 0.6M NaCl in Buffer B. The eluted protein peak was

WO 99/00357

PCT/US98/13496

-53-

pooled and dialyzed overnight at 4°C vs. Buffer C (50 mM HEPES pH 7.5, 5% glycerol, 50 mM NaCl, 2 mM DTT, 0.2 mM PMSF).

5 The dialyzed protein was concentrated in a Centriprep (Amicon) to 3-4 mls and applied to a 2.6 x 100 cm Sephacryl S-100HR (Pharmacia) column. The protein was eluted at a flow rate of 35 mls/hr. The main peak was pooled, adjusted to 20 mM DTT, concentrated to 10-80 mgs/ml and frozen in aliquots at  
10 -70°C or used immediately.

#### EXAMPLE 9

##### Activation of p38

P38 was activated by combining 0.5 mg/ml p38  
15 with 0.005 mg/ml DD-double mutant MKK6 in Buffer B + 10mM MgCl<sub>2</sub>, 2mM ATP, 0.2mM Na<sub>2</sub>VO<sub>4</sub> for 30 minutes at 20°C. The activation mixture was then loaded onto a 1.0 x 10 cm MonoQ column (Pharmacia) and eluted with a linear 20 column volume gradient to 1.0 M NaCl in  
20 Buffer B. The activated p38 eluted after the ADP and ATP. The activated p38 peak was pooled and dialyzed against buffer B + 0.2mM Na<sub>2</sub>VO<sub>4</sub> to remove the NaCl. The dialyzed protein was adjusted to 1.1M potassium phosphate by addition of a 4.0M stock solution and  
25 loaded onto a 1.0 x 10 cm HIC (Rainin Hydropore) column previously equilibrated in Buffer D (10% glycerol, 20mM β-glycerophosphate, 2.0mM DTT) + 1.1MK<sub>2</sub>HPO<sub>4</sub>. The protein was eluted with a 20 column volume linear gradient to Buffer D + 50mM K<sub>2</sub>HPO<sub>4</sub>. The double  
30 phosphorylated p38 eluted as the main peak and was pooled for dialysis against Buffer B + 0.2mM Na<sub>2</sub>VO<sub>4</sub>. The activated p38 was stored at -70°C.



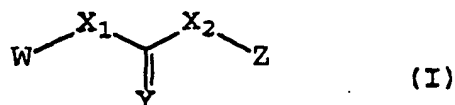
-56-

CLAIMS

We claim:

5

1. A compound of the formula:



10

wherein:

W is a saturated, partially saturated or aromatic monocyclic or bicyclic ring system optionally comprising up to 4 heteroatoms selected from N, O, and S, wherein W optionally comprises upto 4 substituents independently selected from  $\text{R}^1$  and  $\text{R}^4$ ;

15

wherein  $\text{R}^1$  is halogen,  $\text{OR}^3$ ,  $\text{NO}_2$ ,  $\text{NH}_2$ ,  $\text{N}(\text{R}^3)_2$ ,  $\text{CO}_2\text{R}^3$ ,  $\text{CON}(\text{R}^3)_2$ ,  $\text{COR}^3$ ,  $\text{NHCOR}^3$ ,  $\text{SO}_2\text{NR}^3$ ,  $\text{CN}$ ,  $\text{SR}^3$ , 1,2-methyleneoxy, 1,2-ethylenedioxy or  $\text{CF}_3$ ;

20

Y is O, S or NH;

$\text{X}_1$  and  $\text{X}_2$  are independently selected from O, S or  $\text{NR}^2$ ;

25

wherein  $\text{R}^2$  is selected from H or  $\text{C}_1\text{-C}_6$  straight or branched alkyl,  $\text{C}_2\text{-C}_6$  straight or branched alkenyl or alkynyl, wherein  $\text{R}^2$  is optionally substituted with  $-\text{OH}$ ,  $-\text{N}(\text{R}^3)_2$ ,  $-\text{Z}$ ,  $-\text{CO}_2\text{R}^3$  or  $-\text{CO-N}(\text{R}^3)_2$ ;

30

$\text{R}^3$  is selected from H,  $\text{C}_1\text{-C}_6$  straight or branched alkyl,  $\text{C}_2\text{-C}_6$  straight or branched alkenyl or alkynyl, wherein  $\text{R}^3$  is optionally substituted with

WO 99/00357

PCT/US98/13496

-57-

halo, -OH, -OR<sup>4</sup>, -NO<sub>2</sub>, -NH<sub>2</sub>, -N(R<sup>4</sup>)<sub>2</sub>, -CO<sub>2</sub>R<sup>4</sup>, -CO-N(R<sup>4</sup>)<sub>2</sub>,  
-Z, -CN, -SR<sup>4</sup>, CF<sub>3</sub> or -SO<sub>2</sub>NR<sup>4</sup>;

R<sup>4</sup> is independently H, (C<sub>1</sub>-C<sub>6</sub>)-straight or  
branched alkyl, (C<sub>2</sub>-C<sub>6</sub>)-straight or branched alkenyl or  
alkynyl;

Z is selected from C<sub>3</sub>-C<sub>7</sub>-cycloalkyl, C<sub>5</sub>-C<sub>7</sub>-  
cycloalkenyl or monocyclic or bicyclic, aromatic or  
non-aromatic ring systems comprising 5-7 members per  
ring, wherein said ring system optionally comprises up  
to 4 heteroatoms selected from N, O and S, and wherein  
Z optionally comprises up to 4 substituents  
independently selected from R<sup>1</sup> and R<sup>4</sup>.

2. The compound according to claim 1,  
wherein W is an aromatic 5-7 membered monocyclic or  
bicyclic ring system comprising up to 4 heteroatoms  
selected from N, O and S, wherein W comprises upto 4  
substituents selected from R<sup>1</sup> or R<sup>4</sup>.

3. The compound according to claim 2,  
wherein W is an aromatic 6 membered monocyclic ring  
comprising upto 2 heteroatoms selected from N, O and S,  
wherein W comprises up to 4 substituents selected from  
R<sup>1</sup> or R<sup>4</sup>.

4. The compound according to claim 1,  
wherein W is a phenyl or pyridyl ring optionally  
comprising upto 3 substituents selected from halo,  
methyl, methoxy, ethoxy, 1,2-methyleneoxy, 1,2-  
ethylenedioxy, -COOH, -COOCH<sub>3</sub>, or -COOC<sub>2</sub>H<sub>5</sub>.

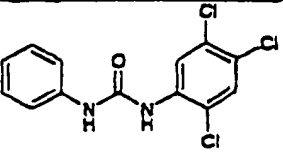
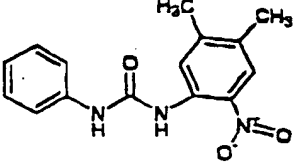
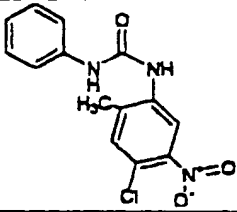
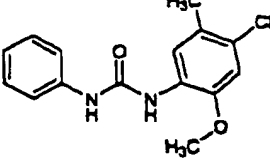
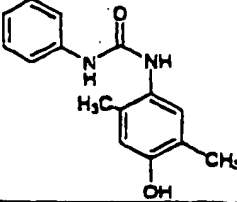
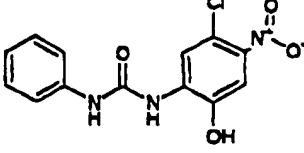
5. The compound according to claim 1,  
wherein Z is a monocyclic or bicyclic, aromatic or non-  
aromatic ring system comprising 5-7 members per ring,  
5 wherein said ring system optionally comprises up to 4  
heteroatoms selected from N, O and S, and wherein Z  
optionally comprises up to 4 substituents independently  
selected from halo,  $OR^3$ ,  $NO_2$ ,  $NH_2$ ,  $N(R^3)_2$ ,  $CO_2R^3$ ,  
 $CON(R^3)_2$ ,  $COR^3$ ,  $NHCOR^3$ ,  $SO_2NR^3$ , CN,  $SR^3$ , 1,2-  
10 methyleneoxy, 1,2-ethylenedioxy,  $CF_3$ ,  $(C_1-C_6)$ -straight  
or branched alkyl,  $(C_2-C_6)$ -straight or branched alkenyl  
or alkynyl.

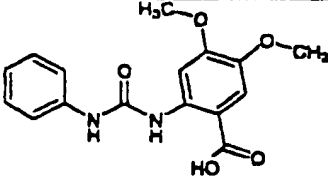
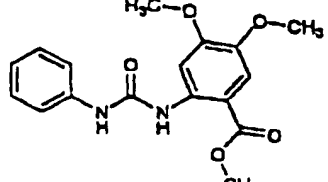
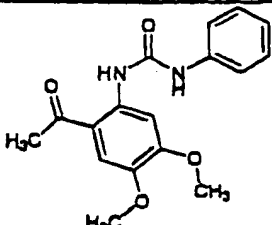
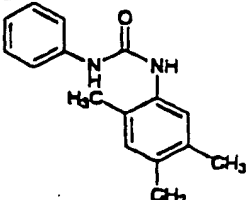
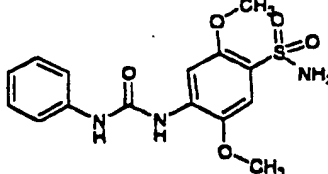
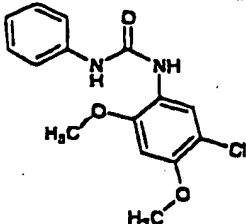
6. The compound according to claim 5,  
15 wherein Z is phenyl or pyridyl, each containing up to 3  
substituents selected from halo,  $OR^3$ ,  $NO_2$ ,  $NH_2$ ,  $N(R^3)_2$ ,  
 $CO_2R^3$ ,  $CON(R^3)_2$ ,  $COR^3$ ,  $NHCOR^3$ ,  $SO_2NR^3$ , CN,  $SR^3$ , 1,2-  
methyleneoxy, 1,2-ethylenedioxy,  $CF_3$  or  $(C_1-C_6)$ -straight  
or branched alkyl.

20 7. The compound according to claim 6,  
wherein Z is 2,4,5-trisubstituted phenyl or 3,4-  
disubstituted phenyl, wherein the substituents are  
selected from halo,  $OR^3$ ,  $NO_2$ ,  $NH_2$ ,  $N(R^3)_2$ ,  $CO_2R^3$ ,  
25  $CON(R^3)_2$ ,  $COR^3$ ,  $NHCOR^3$ ,  $SO_2NR^3$ , CN,  $SR^3$ , 1,2-  
methyleneoxy, 1,2-ethylenedioxy,  $CF_3$  or  $(C_1-C_6)$ -straight  
or branched alkyl.

8. The compound according to claim 1,  
30 wherein the compound is selected from Table 1:

TABLE 1:

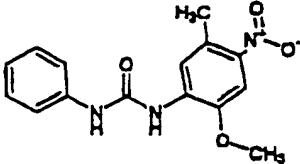
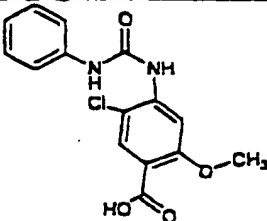
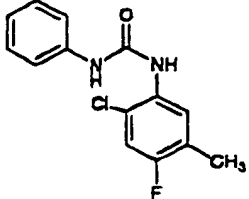
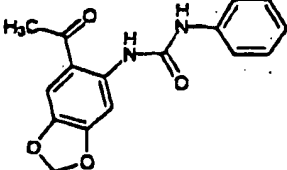
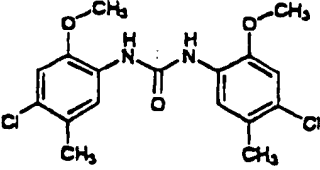
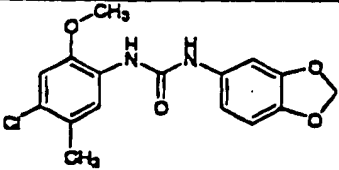
compound number	Structure
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4	
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compound number	Structure
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WO 99/00357

PCT/US98/13496

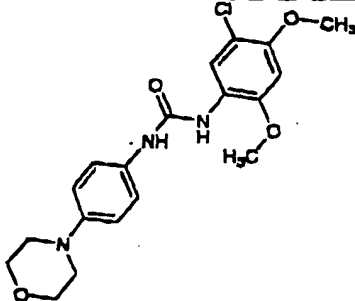
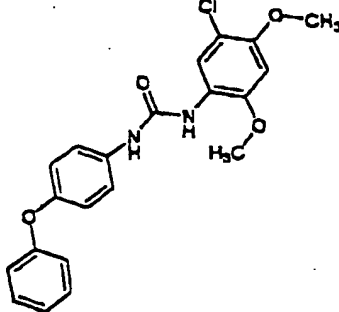
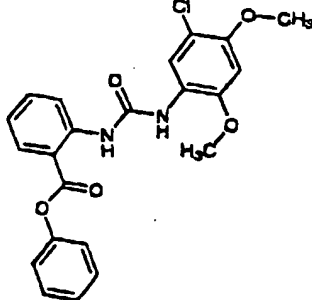
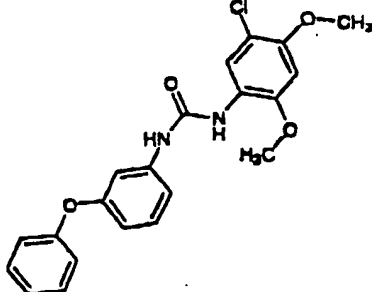
-61-

compound number	Structure
13	
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WO 99/00357

PCT/US98/13496

-62-

compound number	Structure
19	
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WO 99/00357

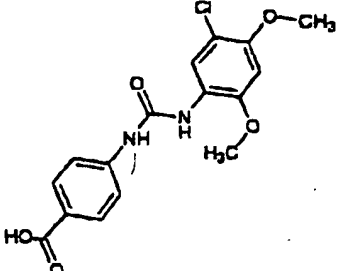
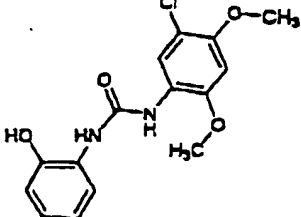
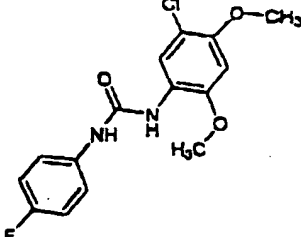
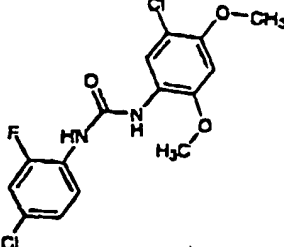
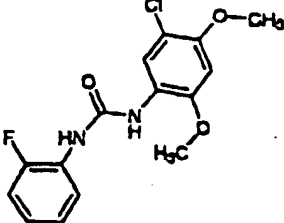
PCT/US98/13496

-63-

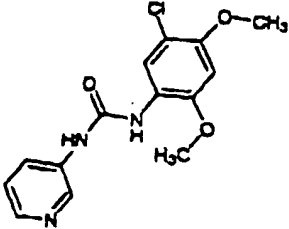
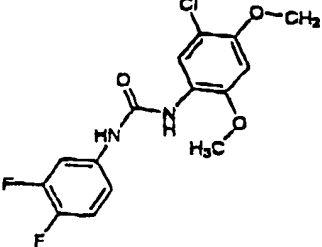
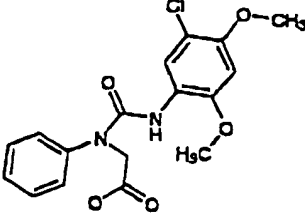
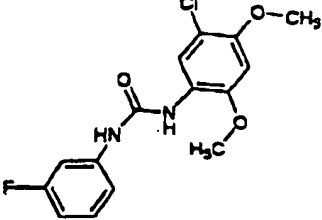
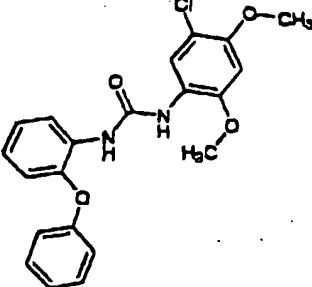
compound number	Structure
23	 <chem>CN(C)c1ccc(NC(=O)Nc2cc(Cl)c(OC)c2OC)cc1</chem>
24	 <chem>Clc1ccc(NC(=O)Nc2cc(Cl)c(OC)c2OC)cc1Cl</chem>
25	 <chem>c1ccccc1NC(=O)Nc2cc(Cl)c(OC)c2OC</chem>
26	 <chem>c1ccc2c(c1)oc3ccccc3o2NC(=O)Nc4cc(Cl)c(OC)c4OC</chem>



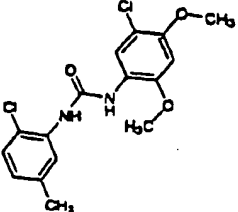
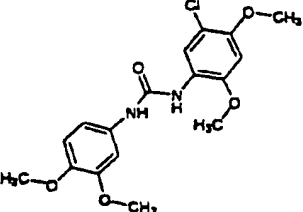
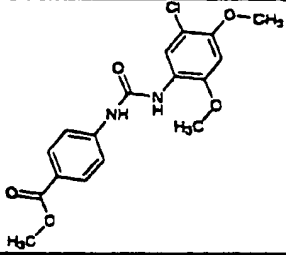
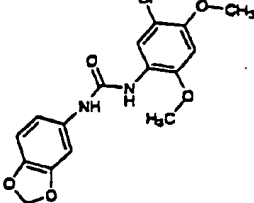
-64-

compound number	Structure
27	 <chem>COc1cc(Cl)cc(NC(=O)Nc2ccc(cc2)C(=O)O)c1</chem>
28	 <chem>COc1cc(Cl)cc(NC(=O)Nc2ccc(O)cc2)c1</chem>
29	 <chem>COc1cc(Cl)cc(NC(=O)Nc2ccc(F)cc2)c1</chem>
30	 <chem>COc1cc(Cl)cc(NC(=O)Nc2cc(F)ccc2Cl)c1</chem>
31	 <chem>COc1cc(Cl)cc(NC(=O)Nc2cc(F)ccc2)c1</chem>

-65-

compound number	Structure
32	 <chem>COC1=CC=C(C(=C1)OC)C(Cl)=CN1C(=O)Nc2ccncc21</chem>
33	 <chem>COC1=CC=C(C(=C1)OC)C(Cl)=NN1C(=O)Nc2cc(F)c(F)cc21</chem>
34	 <chem>COC1=CC=C(C(=C1)OC)C(Cl)=NN1C(=O)N2C(=O)Oc3ccccc3O21</chem>
35	 <chem>COC1=CC=C(C(=C1)OC)C(Cl)=NN1C(=O)Nc2ccc(F)cc21</chem>
36	 <chem>COC1=CC=C(C(=C1)OC)C(Cl)=NN1C(=O)Nc2cc(Oc3ccccc3)ccc21</chem>

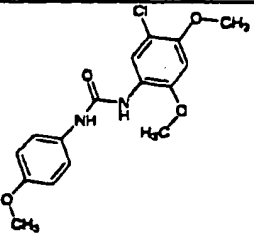
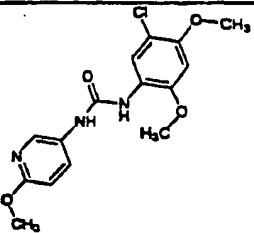
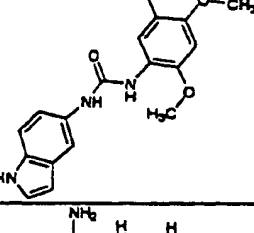
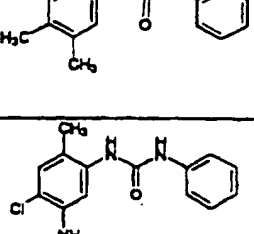

-66-

compound number	Structure
37	
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40	

WO 99/00357

PCT/US98/13496

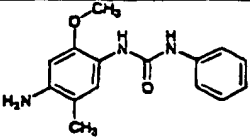
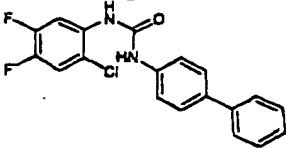
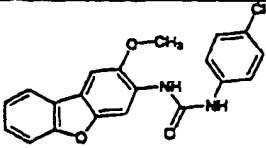
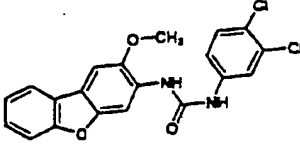
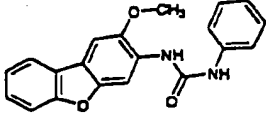
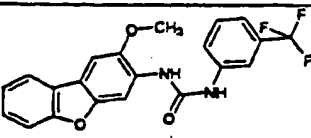
-67-

compound number	Structure
41	
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45	

WO 99/00357

PCT/US98/13496

-68-

compound number	Structure
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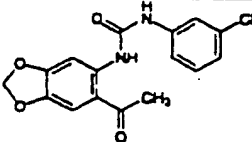
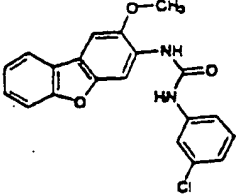
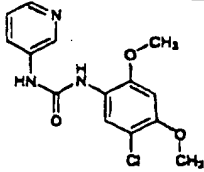
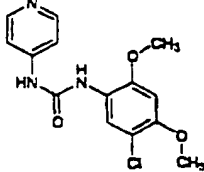
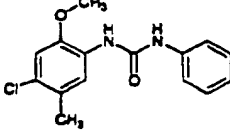
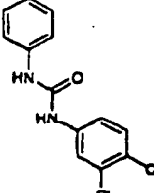
WO 99/00357

PCT/US98/13496

-69-

compound number	Structure
52	 <chem>CC1=CC(=C(C=C1)OC)NC(=O)Nc2ccc(Cl)cc2</chem>
53	 <chem>CC1=CC(=C(C=C1)OC)NC(=O)Nc2ccccc2</chem>
54	 <chem>CC1=CC(=C(C=C1)OC)NC(=O)Nc2ccc(Cl)cc2</chem>
55	 <chem>CC1=CC(=C(C=C1)OC)NC(=O)Nc2ccc(C(F)(F)F)cc2</chem>
56	 <chem>CC1=CC(=C(C=C1)OC)NC(=O)Nc2ccc(Cl)cc2</chem>

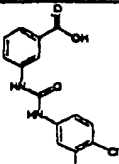
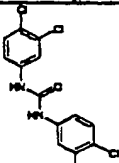
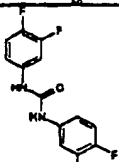
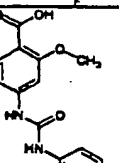
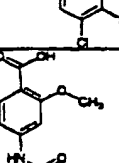
-70-

compound number	Structure
57	 <chem>CC(=O)c1cc2c(c1)oc3ccccc3o2Nc4ccc(Cl)cc4</chem>
58	 <chem>COc1cc2c(c1)oc3ccccc3o2Nc4ccc(Cl)cc4</chem>
59	 <chem>COc1cc(Cl)cc(OC)c1Nc2ccncc2</chem>
60	 <chem>COc1cc(Cl)cc(OC)c1Nc2ccncc2</chem>
61	 <chem>CC1=CC=C(NC(=O)Nc2cc(Cl)cc(OC)c2)C=C1</chem>
62	 <chem>Nc1ccc(Cl)c(Cl)c1NC(=O)Nc2ccccc2</chem>

WO 99/00357

PCT/US98/13496

-71-

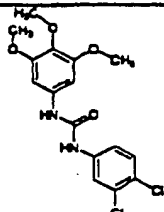
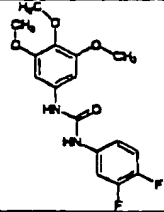
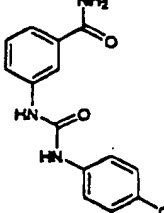
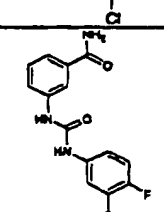
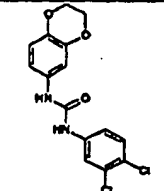
compound number	Structure
63	
64	
65	
66	
67	



WO 99/00357

PCT/US98/13496

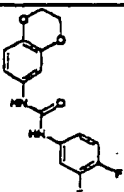
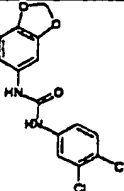
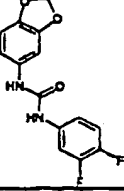
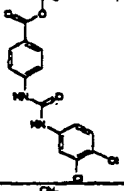
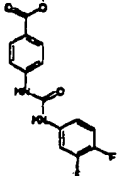
-72-

compound number	Structure
68	
69	
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72	

WO 99/00357

PCT/US98/13496

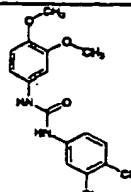
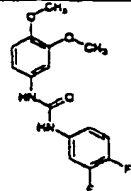
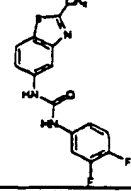
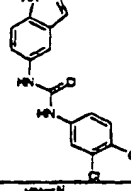
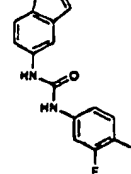
-73-

compound number	Structure
73	
74	
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76	
77	

WO 99/00357

PCT/US98/13496

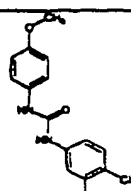
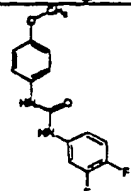
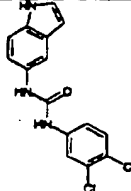
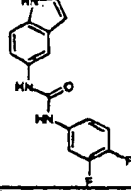
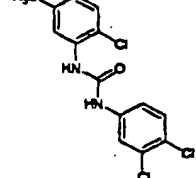
-74-

compound number	Structure
78	
79	
80	
81	
82	

WO 99/00357

PCT/US98/13496

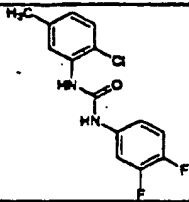
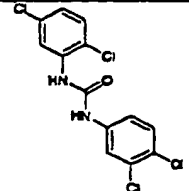
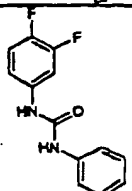
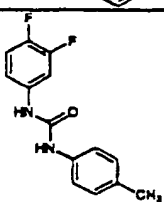
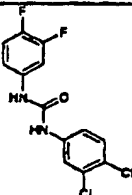
-75-

compound number	Structure
83	
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WO 99/00357

PCT/US98/13496

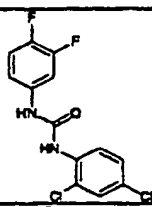
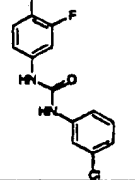
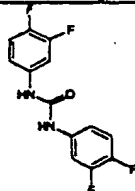
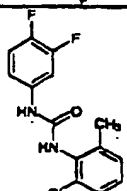
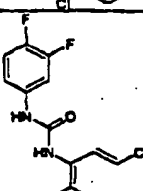
-76-

compound number	Structure
88	
89	
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WO 99/00357

PCT/US98/13496

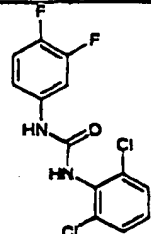
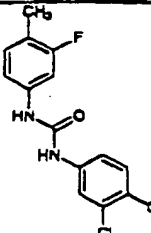
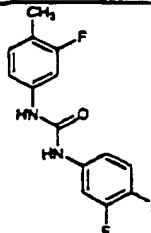
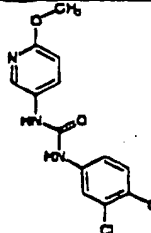
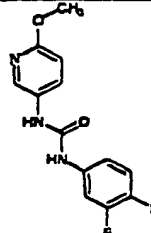
-77-

compound number	Structure
93	
94	
95	
96	
97	

WO 99/00357

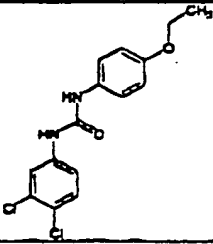
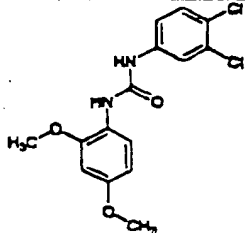
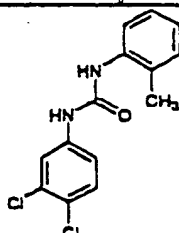
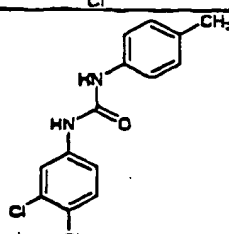
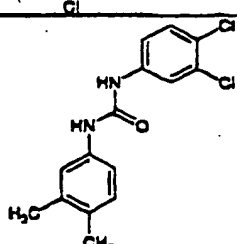
PCT/US98/13496

-78-

compound number	Structure
98	
99	
100	
101	
102	

compound number	Structure
103	 <chem>COc1cc(C)cc(NC(=O)Nc2cc(Cl)c(Cl)cc2)c1</chem>
104	 <chem>COc1cc(C)cc(NC(=O)Nc2cc(F)c(F)cc2)c1</chem>
105	 <chem>COc1cc(C)cc(NC(=O)Nc2cc(Cl)c(Cl)cc2)c1</chem>
106	 <chem>COc1cc(C)cc(NC(=O)Nc2cc(F)c(F)cc2)c1</chem>
107	 <chem>COc1cc(C)cc(NC(=O)Nc2cc(Cl)c(Cl)cc2)c1</chem>



compound number	Structure
108	
109	
110	
111	
112	

WO 99/00357

PCT/US98/13496

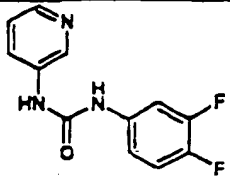
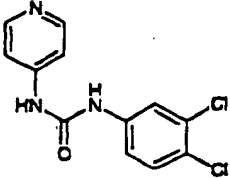
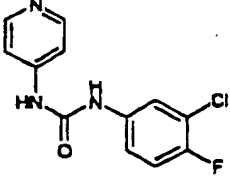
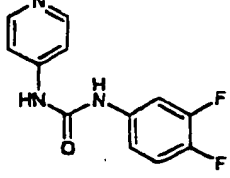
-81-

compound number	Structure
113	 <chem>Cc1cc(C)cc(NC(=O)Nc2cc(Cl)cc(Cl)c2)c1</chem>
114	 <chem>Clc1cc(Cl)cc(NC(=O)Nc2ccc(Cl)cc2)c1</chem>
115	 <chem>CC(=O)c1ccc(NC(=O)Nc2cc(Cl)cc(Cl)c2)cc1</chem>
116	 <chem>CCC(=O)Oc1ccc(NC(=O)Nc2cc(Cl)cc(Cl)c2)cc1</chem>
117	 <chem>Oc1ccccc1NC(=O)Nc2cc(Cl)cc(Cl)c2</chem>

compound number	Structure
118	
119	
120	
121	
122	

compound number	Structure
123	 <chem>COc1ccc(NC(=O)c2ccc(NC(=O)c3ccccc3)cc2)cc1Cl</chem>
124	 <chem>Clc1ccc(NC(=O)c2ccc(NC(=O)c3ccccc3)cc2)cc1</chem>
125	 <chem>BrC1=CC=C(NC(=O)c2ccc(NC(=O)c3ccccc3)cc2)C=C1</chem>
126	 <chem>Clc1ccc(NC(=O)c2ccc(NC(=O)c3ccccc3)cc2)cc1</chem>
127	 <chem>Clc1ccc(NC(=O)c2ccc(NC(=O)c3ccccc3)cc2)cc1</chem>

compound number	Structure
128	 <chem>COC(=O)c1ccc(Cl)cc1NC(=O)Nc2c3ccccc3nc2-c4ccccc4</chem>
129	 <chem>Clc1ccc(Cl)cc1NC(=O)Nc2c3ccccc3nc2-c4ccccc4</chem>
130	 <chem>Clc1ccc(Cl)cc1NC(=O)Nc2c3ccccc3nc2-c4ccccc4</chem>
131	 <chem>Clc1ccc(Cl)cc1NC(=O)Nc2c3ccccc3nc2-c4ccccc4</chem>
132	 <chem>Clc1ccc(Cl)cc1NC(=O)Nc2c3ccccc3nc2-c4ccccc4</chem>
133	 <chem>Clc1ccc(Cl)cc1NC(=O)Nc2c3ccccc3nc2-c4ccccc4</chem>

compound number	Structure
134	
135	
136	
137	

5           9. A pharmaceutical composition comprising  
an amount of a compound according to any one of claims  
1 to 8 effective to inhibit p38, and a pharmaceutically  
acceptable carrier.

10           10. A method of treating or preventing  
inflammatory disease, autoimmune disease, destructive

-86-

bone disorder, proliferative disorder, infectious disease, viral disease, or neurodegenerative disease in a pateint, said method comprising administering to said patient a composition according to claim 9.

5

11. The method according to claim 10, wherein said method is used to treat or prevent an inflammatory disease selected from acute pancreatitis, chronic pancreatitis, asthma, allergies, or adult  
10 respiratory distress syndrome.

10

12. The method according to claim 10, wherein said method is used to treat or prevent an autoimmune disease selected from glomerulonephritis,  
15 rheumatoid arthritis, systemic lupus erythematosus, scleroderma, chronic thyroiditis, Graves' disease, autoimmune gastritis, insulin-dependent diabetes mellitus (Type I), autoimmune hemolytic anemia, autoimmune neutropenia, thrombocytopenia, atopic  
20 dermatitis, chronic active hepatitis, myasthenia gravis, multiple sclerosis, inflammatory bowel disease, ulcerative colitis, Crohn's disease, psoriasis, or graft vs. host disease.

20

25

13. The method according to claim 10, wherein said method is used to treat or prevent a destructive bone disorders selected from osteoarthritis, osteoporosis or multiple myeloma-related bone disorder.

30

14. The method according to claim 10, wherein said method is used to treat or prevent a proliferative disease selected from acute myelogenous leukemia, chronic myelogenous leukemia, metastatic  
35 melanoma, Kaposi's

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WO 99/00357

PCT/US98/13496

-87-

sarcoma, or multiple myeloma.

15. The method according to claim 10,  
wherein  
5 said method is used to treat or prevent an infectious  
disease selected from sepsis, septic shock, or  
Shigellosis.

16. The method according to claim 10,  
10 wherein said method is used to treat or prevent a viral  
disease selected from acute hepatitis infection, HIV  
infection or CMV retinitis.

17. The method according to claim 10,  
15 wherein said method is used to treat or prevent a  
neurodegenerative disease selected from Alzheimer's  
disease, Parkinson's disease or cerebral ischemia.

18. A method of treating or preventing  
20 ischemia/reperfusion in stroke, or myocardial ischemia,  
renal ischemia, heart attacks, organ hypoxia or  
thrombin-induced platelet aggregation in a patient,  
said method comprising the step of administering to  
said patient a pharmaceutical composition according to  
25 claim 9.

19. A method of inhibiting prostaglandin  
endoperoxide synthase-2 in a patient, comprising the  
step of administering to said patient a pharmaceutical  
30 composition according to claim 9.

20. The method according to claim 19,  
wherein said method is used to treat or prevent edema,  
fever, analgesia or to manage pain.  
35



WO 99/00357

PCT/US98/13496

-88-

21. The method according to claim 20, wherein said pain is selected from neuromuscular pain, headache, cancer pain, dental pain or arthritis pain.